An-Najah National University
Faculty of Graduate Studies

Effects of Irrigation with Saline Water on the Growth and Yield of Cherry Tomato

by

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This Thesis was defended successfully on .... and approved by :

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Dedication

To home I love

Father

Mother

Sisters

Brothers

Friends

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ABSTRACT

Effect of Irrigation with Saline Water on the Growth and Yield of Cherry Tomato

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In 1998/1999 season, cherry tomato plants were grown under plastic house conditions in pots. The experiment was conducted at An-Najah National University / Faculty of Agriculture – Tulkarem Campus, to study the effects of irrigation with saline water on cherry tomato yield and fruit quality parameters.

Different levels of salinity were used to study the effect of salinity on cherry tomatoes. As these plants grown in pots, additions of salts were expressed in terms of weight of salt added in term of weight of salt added per unit weight of dry soil ((0,1,3,6and 8 gm of salt per kg soil). The effects of irrigation levels also used (low, medium, high levels), in addition to the effect of three type soils also studied. The effect of fertilizers amount

were studied by using different doses of N-P-K, and the effect of mulch cover also studied to study effect of mulch cover on plant tolerance to salinity.

**It was found that :

- As the salinity increased the yield and the vegetative growth in the different treatments were reduced but the amount of reduction differ between different treatments.
- Were it was found that with mulch cover and clay soil, regular fertilizers N1-P1-K1, and medium irrigation level the reduction in the yield as the salinity increase was less among other treatments (the threshold value ($a = 4.5$ and the slope $b = 0.0584$).
- With increasing the amount of Phosphorus and potassium fertilizers the reduction of the yield as the salinity increase were reduced.
- For the quality parameters it is found that as the salinity increase many quality parameters increase as TSS, reducing sugar, vitamin C, and titrable acid.
- As the plant stress increases these Quality parameters were better as the salinity increase and the irrigation level was reduced as in the sandy soil.
- The PH didn't differ with the different treatments.

Introduction

1. Introduction

1.1 Importance

Agriculture is the backbone of the Palestinian economy contributing about 25 to 30 percent of the Gross National Product (GDP), comprising 25% of the total Palestinian export and employing 17% of the work force (Ministry of Agriculture , 1997).

About 30% of the total area of the West Bank and Gaza Strip are currently under cultivation. Therefore, any changes in the productivity and profitability of this sector can have a direct effect on Palestinian farmers. It is well known that irrigated agriculture is generally more productive and profitable than non-irrigated cultivation. Although only about 6% of the total cultivated area is under irrigation and the agricultural production of this sector represents 52.6% of the total agricultural production.(Ministry of Agriculture, 1997)

Irrigated agriculture is dependent on an adequate water supply of usable quality. Water quality concerns have often been neglected because good quality water supplies have been plentiful and readily available. This situation is now changing in many areas. Intensive use and old projects seeking new or supplemental supplies must rely on lower quality and less desirable sources.

Most water used for irrigation in Palestine is of good to excellent quality and is unlikely to present serious salinity constraints. Large areas of land in Palestine have gone out of cultivation because of the presence of salts. Some soils are naturally saline because geological factor such as marine sedimentation, especially in the Jordan Valley area (ARJI, 1996). However, in irrigated areas, water quality, irrigation methods and practices, soil condition and rainfall mainly affect soil salinity.

In Palestine, where rapid population increase , agricultural, industrial and peculiar geographic condition cause unique problems. The increasing demands on the country limited water resources make urgent broad scale planing and sound decision making to enhance development of all water resources in the State, including those with inferior quality as saline water and sewage water.

The problem of increased salt content in treated wastewater is difficult and costly to control. Therefore, the reuse of treated effluent in irrigating salt tolerant economic crops is important.

Salinity is very significant problem affecting fully one-third of the irrigated land on earth especially in arid and semi-arid areas. It has a substantial economic impact on world agriculture with an estimated annual loss amounting to several billion dollars in crop production due to salt build-up (Tisdale, et al., 1985).

Groundwater quality in the Jordan Valley suffers from deterioration making it unsuitable for irrigating all crop varieties, especially those that are sensitive to salinity. This deterioration is due to the over-exploitation of the shallow aquifer tapped by Palestinian wells there, scarcity of rainfall and the replenishing of water, (Assaf, K. 1991).

Tomato *(L. esculentum Mill.)* is one of the most important vegetable crops in many countries and one of the most important vegetable crops grown under plastichouse in Palestine. Agricultural statistics for the 1988 - 1996 period indicate that the number of plastic houses and gross production (ton) of tomato from year to year increased as shown in (Table 1.3). Within this species, the commercial production of cherry tomato *(L. esculentum var. cerasiforme)* with fruit size ranging from 1.5 to 3.0 cm in diameter is increasing, due among other factors, to their high quality (Hobson and Bedford, 1989).

Cherry tomato *(L. esculentum var. cerasiforme)* is almost certainly the direct ancestor of the modern cultivated forms. Cherry tomatoes are the only wild tomatoes found outside South America. In spite of its small fruit (1.5-3 cm diameter) *L. esculentum var. cerasiforme* is used for human consumption in many regions around the world (Rick, 1974). It is considered important for cherry tomatoes to have an interesting and distinctive flavor profile so that the public should continue to be satisfied with the product (Hobson, 1988).

Cherry tomatoes are gaining worldwide importance and some workers have pointed out that small-fruited tomato varieties are normally more salinity-tolerant than are the normal-fruited ones (Hobson,1988). Records indicate that more area in the world is planted with cherry tomato. As an example we can take the increase of area planted with cherry tomato in Israel area as the statistical reports of the Israeli Ministry of Agriculture reported from 1990 to 1997 as shown in (Table 1.2). Which show the increase of interesting with these crops, which produced for external market.

1.2 Irrigation water in Palestine:

Palestinian suffers from water scarcity because of its arid and semi arid climatic conditions and rain fall variability, The water scarcity is resulting of the abnormal political situation resulting from the long Israeli occupation, and Israel's complete control over all natural resources in Palestine. One of the most difficult problems in the final status negotiations between Israelis and Palestinians that on water.

The main source of irrigation water in Palestine at present time is ground water. The total annual Palestinian water use in irrigated agriculture in the West Bank is 89 Million cubic Meter (MCM), (ARIJ 1996).The maximum quota set by the Israeli authorities for the Palestinians water withdrawal from wells for irrigation in the West Bank is 36 MCM/year. The remaining 53 MCM/year comes from springs distributed all over the West Bank. Total agriculture water demand in relation to actual water use for agriculture in districts of West Bank shown in (Table 1.1).

These quantities of water are pumped from West Bank aquifers in different district are use for agricultural irrigation. In the Gaza Strip the amount of water used for irrigation is 85 MCM/year pumped from the shallow coastal aquifer.

Current Palestinian waters extraction for all purposes represent 17.8% of the safe yield of the West Bank aquifers while the total extraction represents 27.8%. Ten percent were being extracted by Israeli colonies in the West Bank. It's clear that the Palestinian agricultural sectors consuming about 75% of the total water consumption (ARIJ 1996).

1.3 Study Objectives: -

The main objective of this study is to determine the effect of water salinity on the yield and quality of the cherry tomatoes with various cropping conditions including soil type, watering intensity, nutrient availability and mulching application.

Table 1.1 Agricultural Area, Water Use and Demand by District in the West Bank ,(ARIJ, 1996)

District	Total Area (Dunum)	Actual Water Use (MCM)	Optimal Water Use (MCM)	Water Deficit/ Surplus (MCM)
Jenin	11779	4.04	10.55	-6.51
Tulkarem	29345	16.62	22.53	-5.91
Nablus	4639	14.65	3.33	11.31
Jerusalem	0	0.00	-	-
North JV*	28961.5	17.28	15.56	1.72
Jericho	24194	34.84	44.68	-9.84
Ramallah	890	1.17	0.72	0.45
Bethlehem	814	0.37	0.45	-0.08
Hebron	993	0.17	0.32	-0.15
Total	101615.5	89.14	98.14	-9.00

*Northern Jordan Valley

** Optimal water : it is a predicted or forecasted value.

Table 1.2 : The Area Planted With Cherry Tomato in Israel during 1990 – 1997

Year	Area / dunum
1990	5
1991	100
1992	200
1993	300
1995	500
1997	800

**Source : (Statically reports , Ministry of Agriculture, Israel)

Table 1.3 : Tomato Production In Palestine During The Period 1996 –1998

Year	Unirrigated planted			Open irrigation			Plastic house planted			Total		
	Area Dunum	Production Kg/dunum	total Production/Ton	Area Dunum	Production Kg/dunum	Total Production/Ton	Area dunum	Production Kg/dunum	Total Production/Ton	Area dunum	Production Kg/dunum	total production/Ton
1988	17843	1087	19392	10200	3681	37548	50	6420	321	28093	2038	57261
1989	23744	433	10276	9968	3979	39667	99	5856	580	33811	1494	50523
1990	22704	1025	23274	8921	3561	31769	22	7909	174	31647	1744	55217
1991	26372	445	11732	9734	3202	31172	143	6070	868	36249	1290	43772
1992	23760	999	23735	10108	2827	28572	67	11104	744	33935	1563	53051
1993	20891	784	16376	9099	4379	39802	220	11582	2548	30201	1945	58726
1994	17248	235	4050	8196	3796	31112	277	13473	3732	25721	1512	38894
1995	17637	350	6179	7846	3690	28951	545	12473	6798	26028	1611	41928
1996	10885	979	10654	10148	3801	38569	709	13836	9810	21742	2715	59033

**Source : Ministry of Agriculture , Palestine

Literature Review

2. LITERATURE REVIEW

2.1 General

Irrigated water contains a mixture of naturally occurring salts; Soils irrigated with this water contain a similar mix but usually with higher concentration than in the applied water. The extent to which the salts accumulate in the soil will depend upon the irrigation water quality, irrigation management (applied depth, irrigation intervals and frequency), crops and cropping system, and the adequacy of drainage. If salts become excessive, losses in yield will result (Ayers and Westcot, 1989).

A salinity problem exists if salt accumulates in the crop root zone to a concentration that causes a loss in yield. Excessive salinity stunts the crop by reducing the available water in the root zone and this result in slowing crop growth and restricting root development. With higher salinity water, sodium and chloride toxicity are also likely to be evident. In irrigated areas, these salts often originate from a saline, high water table or from salts in the applied water. Yield reductions occur when the salts accumulate in the root zone to such an extent that the crop is no longer able to extract sufficient water from the salty soil solution, resulting in a water stress for a significant period of time. If water uptake is appreciably reduced, the plant slows its rate of growth. The plant symptoms are similar in appearance to those of drought, such as wilting, or a darker, bluish-green color and sometimes thicker, waxier leaves (Ayers and Westcot, 1989).

Poor quality water is being used in several places in the world. Its use requires careful management to prevent or cope with the potential problems related to the water. Often this water is the only supply available and while crop yields may not be at a maximum, they continue to provide an economical return. The infiltration rate generally increases with increasing salinity and increasing in the sodium content relative to calcium and magnesium, the Sodium Adsorption Ratio (SAR). Therefore, the two factors, salinity and SAR, must be considered together for a proper evaluation of the water infiltration rate. An infiltration problem occurs if the irrigation water does not enter the soil rapidly enough during a normal irrigation cycle to replenish the soil with water needed by the crop before the next irrigation (Tillman, 1981).

The technology of combating salinity in soil is extremely costly, required large expenditures of energy to reclaim land and maintain salt balance. Apossible alternative is the introduction of crop species capable of tolerating high soil salinities and producing economic yields under such conditions. Collections of important economic crop species will undoubtedly continue to be screened with a view to identifying outstandingly tolerant cultivars. However, with the possible exception of barley, wheat, and rice, most intraspecific comparisons of salt tolerance have included very few cultivars of the particular crop being studied .To avoid problems when using these poor quality water supplies, there must be sound planning to ensure that the quality of water available is put to the best use (Ayers and Westcot, 1989).

All plant do not respond to salinity in a similar manner; some crops can produce acceptable yields at much greater soil salinity than others. This is because some are better able to make the needed osmotic adjustments enabling them to extract more water from a saline soil. The ability of the crop to adjust to salinity is extremely useful. In areas where a build–up of soil salinity cannot be controlled at an acceptable concentration for the crop being grown, an alternative crop can be selected that is both more tolerant of the expected soil salinity and can produce economical yield.

The timing of irrigation to prevent water stress will improve the chances for success when using higher salinity water. Irrigation timing may include increasing irrigation frequency and irrigation prior to a winter rainy season. The goal of irrigation timing is to reduce salinity and avoid water stress between irrigation. Water stress between irrigation can often be eliminated by increasing the frequency of irrigation, there by preventing excessive root zone depletion caused by too long an interval between irrigation. By decreasing the interval between irrigations, higher soil-water availability is maintained.

Saline areas in the field are normally dark green to blue-green, indicating that they are well supplied with nitrogen. If yellow, additional nitrogen should improve yield (Ayers and Westcot 1989).

One approach to control salinity is leaching of soluble salts from the root zone area by over-irrigation. Such a practice is no longer feasible because of decreasing fresh water resources and rising saline water tables. Alternative approaches that are being resorted to involve breeding, selection and introduction of tolerant cultivars. Exploring the possibility of using certain soil amendments and actions that could possibly alleviate the detrimental effects of salt and specific-ion stress (Ayers and Westcot 1989).

It has been known for many years that salinity improves tomato fruit quality in term of taste, color and the concentration of soluble solids, especially sugars and acids. However, improved quality is usually accompanied by reduced yields. Many scientists who reported that tomatoes are especially sensitive to salinity at young seedling stage during which salinity stress apparently imposes irreversible damage to plant growth have studied the response of tomatoes to salinity. It was also found that salinity reduces tomato yield mainly by affecting its fruit weight. On the other hand, salt tolerance seems to be connected with the plants ability to increase the concentration of solutes in its tissues (Satti and Al-Yahyai, 1995).

Much of tomato is grown under plastic houses conditions in areas close to the Mediterranean sea, where salinity problems already exist because the well waters used for irrigation contain high amounts of soluble salts, mainly chlorides and sulfates (Martinez et al., 1987). This problem is growing year to year due to the scare rainfall and the over-growing demand of water for agriculture, so there is increasing grower interest in using irrigation water more efficiently and in using saline water to partially satisfy crop water requirements.

2.2 Definition of Salt Tolerance

Plant salt tolerance or resistance is generally thought of terms of the inherent ability of the plant to withstand the effects of high salts in the root zone or on the plant's leaves without a significant effect.

Lunin et al. (1963) proposed a couple of ground rules for salinity studes: (1) the actual tolerance of a given crop to salinity will vary according to the growth stages at which salinization is initated and the final level salinity achieved; (2) salt tolerance values Sould also take into consideration the portion of plant to be marketed. Their study demonstrate that salinity caused greater reductions in beet roots than tops, whereas yield reductions for onion bulbs were less than those observed in the tops. In addition, salt tolerance genes function in concert with other genes that influence both quantitative trial and environmental interactions.

In terms of its measurement, salt tolerance is described as a complex function of yield decline across a range of salt concentrations (Mass and Hoffman, 1977; van Genuchten and Hoffman, 1984). Salt tolerance can be adequately measured on the basis of two parameters: the threshold (EC_t), the electrical conductivity that is expected to cause the initial significant reduction in the maximum expected yield (Y_{max}) and the slope (s) (Fig. 1). Slope is simply the percentage of yield was expected to be reduced for each unit of added salinity above the threshold value. Relative yield (Y) at any salinity exceeding EC_t can be calculated :

$$Y = 100\% - s(EC_e - EC_t)$$

Where ECe > ECt.

ECe : Salinity of soil extract

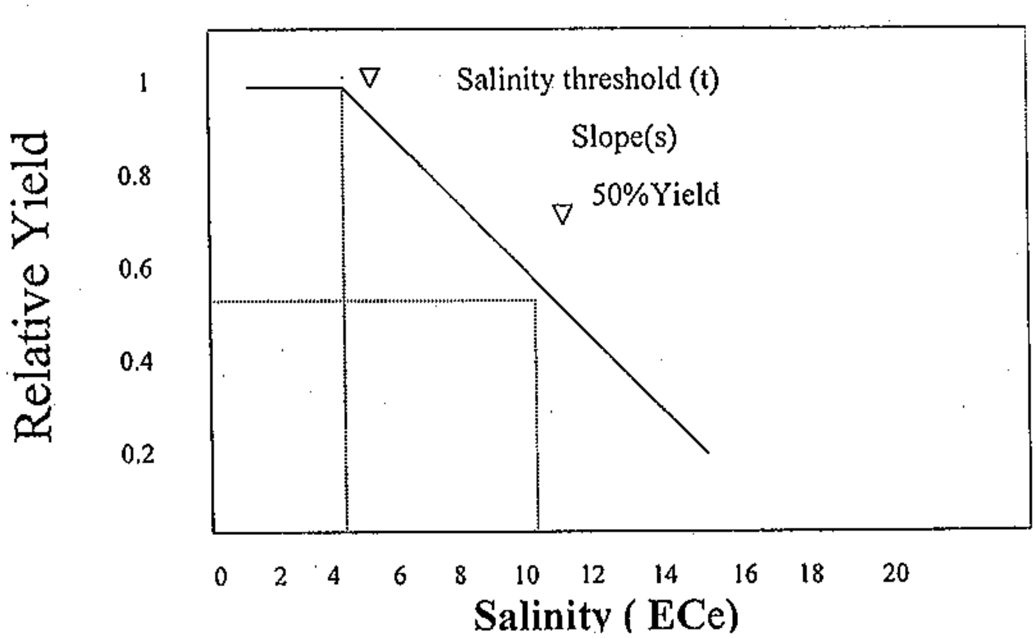

Fig .1. Salt Tolerance Parameters Relating Relative Yield to Increase Salinity in the Root Zone.

The crop salt tolerance threshold ECt, i.e. the salt concentration at which yield first declines with increasing salt concentration, is very sensetive to environmental interactions.

Important environmental factors that show significant interaction with salinity include Evapotranspiration, light, and air pollution. High temperatures and low humidities may decrease crop salt tolerance by decreasing the effective value of EC_t and decreasing the value of s. Thus, significant reductions in yields will be realized at lower salinities, and yields will decreased more rapidly with increasing salinity under hot, dry conditions.

As reported by (Maas, 1984) plant tolerance to salinity is usually appraised in one of three ways:

(1) The ability of a plant to survive on saline soils.

(2) The absolute plant growth or yield

(3) The relative growth or yield on saline soil as compared with nonsaline soil.

Most nonwoody crops are not specifically sensitive to Cl^-. One exception to this generalization involves certain cultivars of soybeans. Salt-sensitive cultivars accumulate excessive amount of Cl- that is toxic to the plants. This problem has been avoided, however, by breeding cultivars that exclude Cl^- .

The following paragraphs summarize the previous research work conducted on the effect of salinity, fertilizer, watering quantity, and mulching on tomato fruit quality and tomato plant growth and yield.

2.3 Effect of Salinity on Tomato Fruit Quality :

Martinze, et al. (1987) reported that the total soluble solids and titrable acidity increased with increasing salinity in all tomato hybrids. The percentage of soluble solids of these tomato hybrids are markedly high, the effect of treatment on percent of glucose was much less consistent since it only increased at intermediate salinity levels. This means that the quality of the product is better, which could compensate partially for the lower yields.

Rylski, et al. (1987) reported that in addition to the positive effect of salinity on the soluble solids content, a major parameter of fruit quality, salinity also had significant effects on three major fruit quality disorders – blossom end rot, blotchy ripening and fruit cracking. Percentage of fruit affected by blossom –end rot was increased by saline irrigation. Saline irrigation improved fruit quality with respect to the disorders of fruit cracking and blotchy ripening. Saline irrigation nearly eliminated fruit cracking in the determinate (cv.BAR54) and significantly decreased the incidence of the disorder in the more sensitive (cv.121). This decrease due to salinity was observed in both the open field and plastic house.

According to Katerji et al.(1998) the increase in salinity reduced water consumption as indicated by a lower water tension and a more effective leaching of salts . Most of the water consumption and salt distribution took place in a relatively small soil volume close to the emitters. Both sodium and potassium salinities improve fruit quality as indicated by an increase in firmness, TSS, sugars, and sugar to acid ratios, and a decrease in hollowness. With increase in sodium salinity caused an increase in Cl^- and Na^+ concentration in fruit, but no effect on the concentration of other ions except for a slight decrease in K^+.

Katerji et al.(1998) reported that both fruit number and weight determine the fruit yield of a tomato plant. It is well known that salinity decreases tomato yield above 2.5-3dSm^{-1} of EC in the extract. At moderate salinity, fruit yield is more affected by the fruit weight than by their number, while at high salinity, both parameters are affected. Some preharvest factors, such as climatic conditions and cultural practices, including soil type and water quality, influence the composition and quality of tomatoes. Tomato flavors, unquestionably, an important characteristic of fruit quality for the fresh market. This character involves the combination of many chemical constituents such as hexsose and organic acids, which are the major components of soluble solids, being also strongly important for fruit quality and for the processing of concentration (Satti et al., 1994). Soluble sugars and organic acids and their interactions are important for sweetness, sourness and flavor intensity.

Fructose and citric acid are more important for sweetness and sourness than glucose and malic acid. When both sugars and acids are low, the result is a tasteless, insipid tomato (Grierson and Kader, 1986). According to Katerji et al (1997) light intensity, reduced soil moisture and salt stress increases sugar content, while the acid concentration is related to the potassium content, which can be affected by factors like salinity.

Alfocea et al, (1993) found that there was Positive correlation between relative growth rate, starch level and the rate of the starch accumulation Also they found that in tomato fruit. Starch accumulations early in fruit development correlated with carbon import rate (Hewitt et al., 1987). However, under salinity and water deficit, reduced fresh weight, increased starch and decreased hexose accumulation were observed in experiments where tomato fruits were analyzed starting from the third week after anthesis (Alfocea et al., 1993).

According to Hobson, (1988) within the cultivated tomato, total dry matter generally comprises 4 to 7.5% of the fruit, of this total dry matter, the soluble and insoluble solids account for approximately 75 and 25%, respectively. Glucose and fructose are the major components of the soluble solids, comprising approximately 50% of the total solids. Sucrose is present in very small quantities, generally less than 0.1% of the fresh weight. The remaining soluble solids are composed of organic acids (primarily citric and malic), lipids, minerals and miscellaneous compounds (pigments, volatiles, etc). The insoluble solids have been studied in less detail but include protein, cellulose, pectic substances and hemicellulose. While both soluble and insoluble solids are important components of tomato fruit.

Pasternak, et al., (1986) reported that when salt – tolerant, edible crops are grown under saline conditions, the flavor of the product was better, although often at the expense of marketable yield. Salt tolerance seems to be linked with an ability to increase the concentration of solutes in plant tissues.

As Hobson and Bedford, (1989) it is considered important for cherry tomatoes to have an interesting and distinctive flavor profile so that the public should continue to be satisfied with the product. While the choice of cultivar plays some part in consumer preference, much can be done to improve flavor through increasing the conductivity of the nutrient solution.

According to (Gough and Hobson, 1990) they found that with cv. Garden Delight, there is no loss in total crop weight in the conditions used with salinity values up to 5 dSm^{-1}, but with benefit to the fruit size so that considerably more of the crop grads within the commercial limit of 35 mm diameter. A salinity trial carried out by (Ehret and Hobson, 1986) with normal-sized, round tomatoes showed that the accumulation of dry matter per individual fruit was not affected by increase in the conductivity of the nutrient solution between 2 and 17 dSm^{-1}. On evidence from results presented here, this effect does not extend to cherry tomatoes.

A positive preférence by consumers for both normal-sized, round (Mizrahi, 1982; Mizrahi et al., 1988) and cherry tomatoes grown at high salinity rather than at lower levels. Men and women tasters have somewhat responded differently to differences in sweetness than in acidity. This was despite the fact that they found significant differences for organic acid contents with increasing salinity, but not for reducing sugars .One of the main effects of salinity increases in the nutrition of tomato plants is on the dry matter content as a percentage of the fresh-fruit weight. Within this dry matter are increases in titrable acidity, and in the sodium and potassium content of the fruit sap. Potassium particularly improves visual and compositional fruit quality, generally also reducing fruit size.

Mizrahi and Pasternak, (1985) reported that the juice of ripe processing tomatoes from plant exposed to increasing degrees of salinity showed increases in TSS content, total acidity, and electrical conductivity. The pH of the juice was not changed significantly, except at the highest salinity, pH was reduced. Because of their better taste, the fruits from the salt-treated plants might obtain better prices on the market, which could compensate for the lower yield. This study showed that processing tomatoes also exhibit higher values for TSS and acidity in the juice of fruits from salinized plants. This finding means that the quality of the product is better. It is found that irrigating such tomato plants with saline water for two weeks before the expected time of ripening will increase the TSS and acid contents of the fruits. This late treatment should prevent the yield reduction due to smaller fruits obtained under saline conditions, because by this stage the fruit have almost completed their growth. In effect, they are proposing sodium chloride as special last -season fertilizer for increasing the quality of processing tomatoes. Late application of salt to indeterminate cultivars would reduce yield more, but still can be considered, if high-enough prices would be obtained for better-tasting fruits.

Mizrahi and Pasternak, (1985) reported that in melons, the fresh fruits from salinized plants were tastier than their controls. However, during storage at room temperature, this advantage was reduced, probably due to post-harvest processes leading to a loss of chemicals important for taste. These chemicals are probably not the total sugars measured in the fruit as TSS, because no correlation was found between TSS and the taste score. A loss of volatile chemicals can probably account for this phenomenon, and storage in the cold rather than at room temperature might help preserve the taste after harvest. In iceberg lettuce as well as in peanuts, the salinity of the irrigation water had no detectable effect on the taste. These differences in results might be due to the fact that melons and tomatoes are fruits, while lettuce heads are leaves, and peanuts are seeds.

According to Petersen et al (1998), the dry-matter content (%) of fruit increased with salinity, but there was no effect of salinity source. When the dry-matter content was calculated as g per fruit, it decreased with salinity. The concentration of glucose, fructose and soluble solids in g per 100 g fresh weight increased significantly with salinity, the concentration of titratable acid expressed in g citric acid per 100 g fresh weight increased with salinity. An effect of salinity source was seen only when the concentration of titratable acid was calculated on a fresh-weight basis. In this case, sodium chloride increased the concentration of titratable acid more than the other salts at high salinities. The vitamin C concentration expressed as mg total ascorbic acid per 100 g fresh weight increased with salinity. However, the vitamin C content decreased with salinity when calculated either per fruit or per 100 g dry matter.

Adams, 1991; Adams and Hobson1989, reported that raised salinity improved the fruit composition in terms of a better taste. In agreement with other investigations, the concentration of dry matter, sugars, titratable acid and vitamin C increased with salinity when calculated on the basis of fresh weight. Per fruit, no differences in glucose, fructose or soluble solids content were found, whereas the content of titratable acid and dry matter decrease with increasing salinity.

Alarcon et al, (1994) reported that the cause of decrease in yield due to salinity was a reduction in fruit size rather than in fruit number. In effect, this led to an increase in the percent of fruit in the 20-30 mm diameter range, which is the required size of export quality cherry tomatoes. Furthermore, total yield of export size tomatoes was higher under the saline treatments, as compared to the control, despite the decrease in total yield. Although the saline treatments and the three branch treatment was successful in producing a high yield of export quality cherry tomatoes, even under the highest salinity treatment fruit size of the early crop from the first clusters was too large for export as cherry tomatoes. Salinity also improved the taste of the ripe fruit as evaluated by a taste panel. In correlation with the improvement of taste, the total soluble solids (TSS) were also increased which was, in turn, paralleled by increases in the soluble sugar concentration.

Caro et al. (1991) reported that an increase in the salinity of the nutrient solution and the soil also lowers the osmotic potential of fruits. These finding have particular importance as they reflect an increase in the content of acids, sugars and minerals-factors which affect the quality of tomato fruits. Controlled salinization can be used as a means for achieving better quality fruit.

2.4 Effect of Salinity on Tomato Plant Growth and Production

Marschner, (1983) reported that the higher salt tolerance of certain cultivars of wheat, barley and citrus is related to a more effective restriction of shoot transport of both Na^+ and Cl^-; whereas in soybean cultivars and rootstocks it is primarily related to the restriction of Cl^- transport and retention of Na^+ in root and restriction of its translocation to the shoot seem to play an important role in the salinity tolerance of wild relatives of pigeonea.

Alfocea et al. (1993) reported that the effect of NaCl on plant dry weight varied with duration of the treatment. In the first harvest, only cvs Muchamiel and Volgogradski underwent a significant decrease in their dry weights with salinity. In the second harvest all cultivars were significantly affected, the lowest decreases occurring in cvs Pera and Gc-72. In the both harvests, the increases in Cl^- and Na^+ concentrations with salinity were parallel in most plant parts for all five cultivars, Na^+ concentration being generally higher than those of Cl^- .Generally, K^+ concentrations decreased with salinity in the three plant parts, significant differences being found between the treatments in both harvests. The lowest decreases in K were found in roots and, in some cultivars, these K^+ concentrations even increased with salinity in the first harvest. The stem was the plant part showing the highest K^+ concentrations in the two harvests, both in treated and control plants. The degree of salt tolerance of cultivars, measured on the basis of their decrease in dry weight at different salt level. If the inhibition of the growth is due, on the one hand, to the toxicity of Cl^- and Na^+ ions, and, on the other hand, to the nutritional imbalance induced by salinity, a relationship between plant growth and the Cl^- and / or Na^+, K^+, Ca^{++} and Mg^{++} concentration in root, stem and leaf should be found. The more sensitive the cultivar, the higher the level of the correlation between the dry weight and the ion concentration. They suggest that there will only be a correlation between the dry weight and the ion contents when the salinity level used, or the duration of the salt treatment.

Tal and Guard (1976) and Tal (1985) found those plants of *(Lycopersicon peruvvianum)* and *(Solanum pennellii)* suffered under salinity less than the cultivated tomato. Compared with the cultivated tomato, these wild species showed a lower decrease in dry weight and relative water content under salinity, and they were more succulent and accumulated more Na^+ and Cl^- and less K^+.

Tal and Shannon (1983) found that the wild relatives of the cultivated tomato, *L.cheesmanii, L. peruvianum* are distinguished from the cultivated species by: (1) a lower absolute elongation rate of the stem under control conditions and a smaller relative decrease of this under high salinity; (2) a higher accumulation of Na^+, which was most pronounced in the leaf and top of the shoot; and (3) a greater decrease of K^+ content under salinity, especially in the stem and to a lesser extent in the leaf and the top .

Satti et al., (1995) found that stem height of tomato was reduced by salinity (50mM NaCl) by 11% but was increased by 6% with the application of 4mM K. When K^+ level increased to 8 and 16 mM, stem height decreased by 5 and 8%, respectively. Leaf number was not found to be significantly affected by salinity and K^+. Suppression of plant growth under saline condition is shown by reduced stem height, fruit size, and whole plant dry weights compared to control plants. This reduction could be attributed to osmotic reduction in water availability or to specific ion effect particularly Na^+ and Cl^-. The high amount of Na^+ in saline nutrient solution could have impaired the hydraulic conductivity or permeability of root to water and the displacement of K^+ at the exchange sites in the root thus rendering it less available to the plant possibly resulting in K^+ deficiency

Willumsen et al (1996) found that a clear relationship between salinity and the total weight of harvested fruit. The higher the salinity the more depressed was the weight of yield due to a smaller fruit size. The maximum decrease in both yield and fruit size was 16-25% of the control while the corresponding number of harvested fruit per plant varied only 3-10%. Also the source of salinity significantly influenced both fruit size and yield, the reductions being larger by addition of sodium chloride than by the combined addition of chlorides and sulphates. Leaf length was also reduced by increased salinity, whereas the total fresh weight of all leaves influenced by the treatment.

Adams and Ho, (1989), reported that the reduced leaf length, fruit size and total fruit weight may be explained by a reduction in cell volume due to smaller The number of fruits per plant may also be reduced by increased salinity.

Alarcon et al. (1993,1994) have studied the water relations and the osmotic and elastic adjustment capacity of different tomato genotypes under saline stress, and have shown that the growth of salt-treated tomato plants is often limited by the ability of the root to extract water from the soil and transport it to the shoot.

Rodriguez et al. (1997) reported that at the end of the salinization period, salinity induced a clear reduction in stem, leaf and root dry weight. However, the shoot: root ratio increased significantly in salt-treated plants, indicating that root development was affected more than shoot growth.

According to Caro et al. (1991) Fruit yield of all cultivars decreased with increasing salinity, although variation between cultivars of normal-sized tomatoes and cherry tomatoes was different. In general, the *L. esculentum* cultivars showed significant differences between salinity level 2.8 and 6.3 (dS m-1) and between 6.3 and 13.9 (dS m-1), but there were no significant differences between 13.9 and 21.5 (dS m-1). Cherry tomato cultivars showed similar decreases in vegetative parameters. However, these cultivars had the lowest slopes in the yield-EC response plots. Consequently, the ranking of salinity-tolerant genotypes on the basis of vegetative characteristics may differ from that on the basis of fruit yield.

As Shannon (1985) suggested that when leaf concentration of Cl and Na increased, fruit yields decreased, and Cl- and Na toxicity effects may be one cause of yield decreases when tomato plants grew in media having high NaCl levels. Nevertheless, the fundamental mechanisms determining the responses of plants to NaCl are still not understood. In addition to the osmotic shock, accumulation of Cl and Na ions in the plant is often claimed to be toxic and is even considered to be one of the main causes of growth inhibition induced by salinity.

2.5 Effect of Fertilizers

According to Besford (1978) K^+ is an essential macronutrient and appears to be required by all plant species including tomato, which has a high requirement for this element. An adequate supply of K^+ is important for vegetative growth and the formation of good quality fruits.

According to Tal Shannon(1986) the efficiency of K^+ utilization was similar in all three species under control conditions, but higher in the two wild species than in the cultivated species when K^+ supply was low. At low

K^+ growth of the wild species was impaired less than that of the cultivated species. Lower K^+ content in the leaf characterized the wild salt tolerant plants when grown in control or saline (NaCl) medium.

According to Gibson (1988) Phosphorus applications have increased yield in cereals and pasture species in saline soils at levels of available P sufficient to give maximal yield under normal soil conditions. salinity treatments decreased the concentration of P in both the soil solution and plant leaves. Phosphorus addition to saline media have resulted in relatively low levels of Na^+ and high levels of K^+ in immature leaves of tomato (Awad et al., 1990)

Satti et al. (1995) reported that an improvement in fruit weight was obtained when saline solutions were enriched with K, P and Ca. Percent increase in fruit weight reached a maximum of 194% when K was added to the saline treatment. Fruit yield of cultivars decreased with increasing salinity although variation between cultivars was not significant except for the small-fruited cultivar. When P was added to the saline nutrient solutions, the level of P in tomato leaves was significantly increased by 4-5 fold that of the control plants. However, the use of Ca resulted in a lowering of the P content possibly by interference with its uptake. The requirement for more P in salinized pants could be related to its role in energy fixation and carbohydrate partitioning and transport.

Satti and Al-Yahyai (1995) reported that soil salinity decreased the content and uptake of certain elements in the plant leaves, which might lead to a reduction in growth and yield due to nutrient deficiency. Sodium chloride salinity generally decreased the content of K, Ca, and Mg in the plant. It was also reported by Marschner. (1986) that the K, Ca, and Mg concentration in the leaves, in general, decreased with salinity in wheat. The addition of certain elements to the saline soil might correct the deficiency symptoms that occurred due to salinity. The addition of P and Ca resulted in a positive effect on plant mineral uptake.

Norrie et al (1994) reported that salinity buildup in the peat substrate might have decreased yields for high-EC treatments. Also, increased NO_3-N in the high-EC solution may increase vegetative growth and reduce fruit-set under higher spring light conditions. Foliar nitrogen and potassium concentrations were found to be slightly higher in leaves of plants receiving the high-EC solution. Phosphorus concentration did not change between treatments and calcium, although still above critical levels was slightly reduced in leaves of plants receiving high-EC solution.

2.6 Effect of Irrigation Method, Timing and Mulch Cover :

Pasternak et. al. (1986) reported that drip irrigation is thebetter system for application of brackish water to plants than either sprinkler or furrow irrigation. It appears that a major reason for this superiority is the very effective leaching of salts immediately under the drippers (Yaron et. al., 1973). Even when the smallest quantities of water are given, there is always a volume of soil under the emitters in which the salts concentration in the soil solution is equal to that of irrigation water. Apparently, plant growth is determined by the lowest salt concentration in the root profile (Papadopoulos and Rending, 1984).

Rudich et al. (1981) conducted an experiment with processing tomatoes in which scheduled trickle irrigation treatments were applied over five definite growth stages. Their results indicated that a water deficit during the growth stages of flowering, fruit set, the onset of fruit development, and early ripening was critical with respect to yield and that low water tension during these growth stages was essential for maximum yield.

Pastrenak et. al. (1984) reported that under sprinkler irrigation with brakish water the mean electrical conductivity of saturated soil extract (EC_e) was about 6.0 dSm^{-1} and the yield reduction was 60% . With drip irrigation, the EC_e under the drippers was about 5.0 dSm^{-1} and the yield reduction was 30%. Sprinkler irrigation affected yield through a reduction in both bulb size and bulb number of onion per unit area. Drip irrigation affected the bulb number only.

Locascio et al. (1985) reported that Trickle irrigation has been used to produce tomatoes with yields similar to those obtained with overhead irrigation, but with one-half as much water.

Growing tomatoes with polyethylene mulch increases the amount of applied N recovered by trickle-irrigated tomatoes and increases yield over non-mulched tomatoes. Tomatoes and strawberries have responded with increased production with N and K injected into the irrigation water in contrast to all applied preplant. Since, nutrient-leaching increases with the amount of water applied, precise control of the amount of the water and frequency of application may eliminate the need to apply nutrients with the irrigation water. Also, numerous small daily water applications may be more efficient in reducing water stress and nutrient leaching than one large daily application.

Pasternak et. al. (1986) reported that when tomatoes were germinated with fresh water and irrigation with brackish water was begun only after some thirty days of growth, water with an electrical conductivity of 7.5 ds/m reduced the yield of fresh fruit by about 30%. However, if 7.5 dSm^{-1} water was applied from outset, then the yield was reduced by some 60% . It is very important to prevent young tomato seedling from suffering severe salinity stress. Thus, whenever possible, tomatoes should be germinated with fresh water and salinized only at about the fourth-leaf stage (delaying salinization to the eleven-leaf stage gave no further advantage).

In both the straw and plastic treatments, root density decreased at about 22 cm. There appeared to be more root development in straw treatment at the 30- to 60-cm depths under daily irrigation treatment compared to twice weekly, probably due to lower matric potentials that resulted from this irrigation schedule. Under the plastic mulch, root density increased with irrigation. Soil temperature was likely the controlling factor in root development under the plastic mulch. The slightly more favorable temperatures under irrigation may have permitted greater root growth in these treatments than in the control under the plastic mulch.

Materials and Methods

3. Materials and Methods

3.1 Study Location:

The experiment was conducted at AN-Najah National University - Faculty of agriculture at Tulkarem Campus , during the 1998/1999 season.

Tulkarem district was located in the northwestern part of the West Bank. It is bounded by the Jenin and Nablus districts in the North, it lies between 40 to 500m above sea level and it is entirely within the fertile semi coastal zone (ARIJ, 1996).

The climate of Tulkarem is of Mediterranean type with moderate summers and relatively warm winters.

Humidity in Tulkarem reaches high values with an annual average of 69.6%. In winter, this value increases to an average of 75.9% in February while in May it reaches its lowest value of 62.4%. The variation of the average monthly humidity , temperature., rainfall and wind speed for the Tulkarem district from 1980-1995 are shown in Appendix A1(ARIJ, 1996)

3.2 Nutrition and Growing Conditions: -

a. Plant Materials:

A crop of cherry tomato *(Lycopersion esculentum var. cerasiforme, cv. 189)* was grown under plastic house condition in pots.

A plastic house of one dunum area was used. The lay out of the experiment was randomized complete block design with three replicates for each treatment were planted. During September of 1998 the preparation of the experiment began by potting and mixing the soil. The soils were potted using 15litter soil per pot, the pots are made of plastic containers, and the containers were perforated on the sides and bottom for aeration and drainage.

The pots were arranged in six rows in the plastic house and plastic containers were put under each pot for collecting drained water. The distance between each pot were 50 cm in each block, were each block had the same salinity level. The spacing between blocks was 1m, and the spacing between rows was 1.5 m. Plants in each row were subjected to various experimental conditions as follows:

- The first row with clay soil and five levels of salinities were covered with black plastic mulch (45pots).
- The second row with three types of soil and five salinity levels has been used (45pots).
- The third row with three types of soil and five salinity levels were used (45 pots).
- The fourth row with three types of soil and five salinity levels of were used (45 pots).

...h clay soil and five levels of salinities were used with

...lizer doses (45 pots).

- The fifth ...ow with clay soil and five levels of salinities were used

di...erent fertilizer doses (45 pots).

...were transplanted in the pots on 24/9/1998. The plastic house

...s were as shown in the table 2.1 below. And the sketch of the

...ment as shown in appendix A2.

During the growing season ("Manifgan", "Daconil"), ("Benlate", " Rubigan", "Ridomil"), "Benlit", at the rate of (50, 45), (12, 6, 50), and 12gm/20 liter of water respectively, were used with alternate spraying one time a week against early blight, Powdery mildew, Wilting.

Table 3.1 Temperature and Relative Humidity During the Experimental Period Inside the Plastic House

Year	Month	Maximum Temp.	Minimum Temp.	Relative Humidity %
1998	September	32.6	21.6	72
1998	October	30	19	65
1998	November	26.5	16	71.5
1998	December	21.5	12.5	70
1999	January	19	10	78.5
1999	February	19.5	9.5	85
1999	March	21.5	10.5	79
1999	April	24.5	13	78

b. Soil Types and Salinity Treatment:

Three types of soil were used in the study: sandy soil, clay soil, mixture soil (½ sand + ½ clay). The salts were added in the form of NaCl and were mixed with the three types of the soil using a mechanical mixer. Soils were then potted and weighted. Five levels of salinity were used with three replicates for each treatment: 0, 1, 3, 6, and 8 gm NaCl for each 1Kg soil.

c. Irrigation Frequency and Fertigation

The pots were irrigated using a drip irrigation system with tap water at a rate of one liter per plant per day – four days a week. In the first three weeks, the additions of water and fertilizer were the same for all pots until the seedling grew, then the treatment of water and fertilizer began using the following levels and rates (see Tables 3.2 and 3.3):

- Regular fertilizer (N1, P1, K1) and regular water irrigated water 1 (4L/plant/week) added for the first row.
- Regular fertilizer (N1, P1, K1) and half amount of regular water irrigated water 2 (2L/plant/week) were added for the second row.
- Regular fertilizer (N1, P1, K1) and one and half amount of regular water irrigated water 3 (6L/plant/week) added for the third row.
- Regular fertilizer (N1, P1, K1) and regular water irrigated water 1 (4L/plant/week) added for the forth row.

- The fifth r... ...vided into three groups in fertilizer addition each 15 pots ... five level of salinity have different amount of fertilizer

... 1, K2) For each of the five salinity levels, watering level W1, ...d clay soil

(N1, P1, K3) For each of the five salinity levels, watering level W1, and clay soil

. (N1, P2, K1) For each of the five salinity levels, watering level W1, and clay soil

- The sixth row divided into three groups in fertilizer addition each 15 pots with the five level of salinity have different amount of fertilizer as follow:

. (N1, P3, K1) For each of the five salinity levels, watering level W1, and clay soil

. (N2, P1, K1) For each of the five salinity levels, watering level W1, and clay soil

. (N3, P1, K1) For each of the five salinity levels, watering level W1, and clay soil

- The fifth row with clay soil and five levels of salinities were used with different fertilizer doses (45 pots).
- The sixth row with clay soil and five levels of salinities were used with different fertilizer doses (45 pots).

Seedlings were transplanted in the pots on 24/9/1998. The plastic house conditions were as shown in the table 2.1 below. And the sketch of the experiment as shown in appendix A2.

During the growing season ("Manifgan", "Daconil"), ("Benlate", " Rubigan", "Ridomil"), "Benlit", at the rate of (50, 45), (12, 6, 50), and 12gm/20 liter of water respectively, were used with alternate spraying one time a week against early blight, Powdery mildew, Wilting.

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- Regular fertilizer (N1, P1, K1) and half amount of regular water irrigated water 2 (2L/plant/week) were added for the second row.
- Regular fertilizer (N1, P1, K1) and one and half amount of regular water irrigated water 3 (6L/plant/week) added for the third row.
- Regular fertilizer (N1, P1, K1) and regular water irrigated water 1 (4L/plant/week) added for the forth row.

- The fifth row divided into three groups in fertilizer addition each 15 pots with the five level of salinity have different amount of fertilizer as follow :

  . (N1, P1, K2) For each of the five salinity levels, watering level W1, and clay soil

  . (N1, P1, K3) For each of the five salinity levels, watering level W1, and clay soil

  . (N1, P2, K1) For each of the five salinity levels, watering level W1, and clay soil

- The sixth row divided into three groups in fertilizer addition each 15 pots with the five level of salinity have different amount of fertilizer as follow:

  . (N1, P3, K1) For each of the five salinity levels, watering level W1, and clay soil

  . (N2, P1, K1) For each of the five salinity levels, watering level W1, and clay soil

  . (N3, P1, K1) For each of the five salinity levels, watering level W1, and clay soil

Table 3.2 Summary of Salinity and Fertigation Levels

Salinity Level	Nitrogen, mg /plant /season			Potassium mg /plant /season			Phosphorous mg /plant /season		
	N1	N2	N3	K1	K2	K3	P1	P2	P3
0 mg/l NaCl- kg Soil	1000	500	1500	1000	500	1500	300	100	500
1 mg/l NaCl- kg Soil	1000	500	1500	1000	500	1500	300	100	500
3 mg/l NaCl- kg Soil	1000	500	1500	1000	500	1500	300	100	500
6 mg/l NaCl- kg Soil	1000	500	1500	1000	500	1500	300	100	500
8 mg/l NaCl- kg Soil	1000	500	1500	1000	500	1500	300	100	500

Table 3.3 Summary of Salinity, Fertigation, Watering Levels and Soil Types

Salinity Level	Fertigation, mg /plant /season			Watering Liter/plant/week			Soil Type		
	N1	K1	P1	W1	W2	W3	S1	S2	S3
0 mg/l NaCl- kg Soil	1000	1000	300	4	2	6	sand	clay	mixed
1 mg/l NaCl- kg Soil	1000	1000	300	4	2	6	sand	Clay	mixed
3 mg/l NaCl- kg Soil	1000	1000	300	4	2	6	sand	clay	mixed
6 mg/l NaCl- kg Soil	1000	1000	300	4	2	6	sand	clay	mixed
8 mg/l NaCl- kg Soil	1000	1000	300	4	2	6	sand	clay	mixed

And we used the N, P, and K elements from the following sources:

- Potassium (K): from potassium nitrate (KNO_3) which contains 37% pure potassium.

- Nitrogen (N) : from two sources :
- Potassium nitrate(KNO_3)which contain 13% pure nitrogen
- Ammonium sulfate $(NH_4)2SO_4$ Which contain 21% pure nitrogen
- Phosphorus(P) from phosphoric acid (H_3PO_4) which have:

. Specific gravity of H_3PO_4 = 1.69 gm/ml

. Each 1 ml H_3PO_4 contains: 1.69 gm/ml * 0.85 gm H_3PO_4

. So each ml of H_3PO_4 contains:

1.69 gm/ml * 0.85 gm H_3PO_4 *31/98 gm P = .454gm

d. Plant Harvest:

Plants were harvested by hand. Harvesting season started on 15 December and continued until 15 March 1999. Marketable and unmarketable cherry tomato fruits were picked at 7-10 day intervals. During the growing season the field data were recorded at various periods.

3.3 Crop Monitoring:

1- Plant growth and development: measuring the plant height (cm), by measuring the height of the plant each week and the mean length for each block was taken.

2- Quantitative characteristics: measuring the total yield/plant (gm), and the weight of harvested fruit each week for each plant and block were recorded

3- Quali... aracteristics: measuring the average fruit size

...e number of fruits per 100g of fruit was recorded.

...ng and Analysis:

...g and Samples Preparation

...he beginning of the season we collect 15 soil sample was collected, these sample were taken as follows :

- 5 soil sample were collected from pots of the clay soil with the five levels of salinity, each of these samples was about 1 Kg.
- 5 soil sample was collected from the pots of the mixture soil with five levels of salinity, each of these samples was about 1 Kg.
- 5 soil sample were collected from the pots of the sand soil with five levels of salinity, each of these samples was about 1 Kg.

2. During the season 100g of fruit was collected randomly from each block, these fruits were counted and fruits from these samples were taken for another analysis.
3. During the season water samples from the irrigation water were taken and these samples was preserved in a refrigerator until they were send to the laboratory for analysis.
4. At the end of the season, 80 samples of the plant were collected, each sample represent adifferent treatment as shown in table 3.4

Table 3.4: Types of plant samples collected at the end of the season.

Number of sample	Treatment
5	Soil type1 , irr. Level1,(N1-P1-K1) and mulch cover with different level of salinity
5	Soil type 1 , irr. Level 2,(N1-P1-K1) with different level of salinity
5	Soil type 3 , irr. Level 2,(N1-P1-K1) with different level of salinity
5	Soil type 2 , irr. Level 2,(N1-P1-K1) with different level of salinity
5	Soil type 1 , irr. Level 3,(N1-P1-K1) with different level of salinity
5	Soil type 3 , irr. Level 3,(N1-P1-K1) with different level of salinity
5	Soil type 2 , irr. Level 3,(N1-P1-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N1-P1-K1) with different level of salinity
5	Soil type 3 , irr. Level 1,(N1-P1-K1) with different level of salinity
5	Soil type 2 , irr. Level 1,(N1-P1-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N2-P1-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N3-P1-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N1-P2-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N1-P3-K1) with different level of salinity
5	Soil type 1 , irr. Level 1,(N1-P1-K2) with different level of salinity
5	Soil type 1 , irr. Level 1,(N1-P1-K3) with different level of salinity

These collected plant samples were cleaned from the soil and the shoots was separated from the root .The fresh weight of the root and the shoot for each plant were recorded and the sample was prepared for drying.

5. Although at the end of the season soil sample from the pots was collected from each pot as follows:

. one sample from the top of the pot

. one sample from the middle of the pot

. one sample from the bottom of the pot.

Because of sample number limitation to be analyzed, only the treatment of 3gm/kg samples of all different treatment in the experiment were analyzed. The number of these samples were 48 sample.

a. Physical Analysis

- Soil Type:-the type of the soil was known according to its texture so the soil was determined according to the percentage of clay, silt and sand.

- Dry Matter Content: -The dry-matter content calculated as percentage (%) of the shoot and root determined by the plant material was washed with distilled water and dried at 65 °C for 3days, and dry weight was recorded by dividing the dry matter of the shoot or root over the fresh weight of each of them, then calculated as percentage.

c. Chemical Analysis:

- Soil and Water Chemical Analysis: - At the beginning of the experiment 15 soil sample were taken from the three types of the soil el of salinites. These samples and water sample were and the fi their content of EC, Cl-, Ca++, PH, N, P, K+, Ca++ & analy and Na-. The same analyses were conducted for the soil s at the end of the growing season. These analyses were done the staff of technician in Beta Central Laboratory For water and soil analysis of the Palestinian Ministry of Agriculture

- Fruit chemical analysis: during the growing season randomized samples from each treatment was taken and prepared for these analyses.

1. Titrable Acids: - Titrable acids were determined on blended samples titrated to pH 8.1 with 0.1N NaOH and were expressed as g citric acid per 100g fresh weight.
2. Total ascorbic acid was determined by use of the dichloro-indophenol method.
3. Total Soluble Solids (TSS):-Total soluble solids (TSS) Percentage was measured by refractometer (ATAGO , S-10).
4. Reducing Sugar: -Reducing sugar was measured by the method of Carballido et al (1974).
5. Acidity: the pH was determined by using the pH meter (HANNA instruments ,8521).

Result and Discussion

4. Result and discussion

The following sections present and discuss the results obtained in this study as related to the effects of salinity on cherry tomato *(Lycopersicon esculentum va. Cerasifome)* vegetative growth, fruit yield, fruit size, fruit quality expressed as titrable acid, pH, total soluble solid (TSS), vitamin C content, reducing sugar and the dry matter of the shoot and root.

Due to the large number of figures and tables used in this section and for clarity of the discussion, it was decided to put most of them in Appendices B to E.

4.1.1 Effect of Salinity on Fruit Yield:-

Mean plant yields versus irrigation level and salinity was presented in Table 4.1a. Table 4.1a indicates that there is a reduction of yield with increasing salinity at all levels of irrigation treatments. At the same salinity level, yield reduced with reducing amount of irrigation water. It was clear from the same Table that higher yield production was observed under 0gm salt addition and high and medium irrigation water level (4&6Litters/week).

Under low irrigation water level (2Litter/week) the effect of salinity is clearer, and there is a greater decrease in the yield in response to irrigation water decrease. In other words, the effect of salinity on the plant increases as the soil should not be allowed to dry because the osmotic potential retards water uptake.

Also, no significant difference was found in plant yield between medium irrigation level and high irrigation level, so there is no need to increase the amount of water to greater than 4Litter/ week.

Table 4.1a Mean Yield under Different Salinity Levels and Different Irrigation Levels.

Salinity	Yield (gm/plant)		
	Medium Irrigation Level	Low Irrigation Level	High Irrigation Level
0	1056.73 (a)	985.17 (c)	1025.77 (b)
1	981.5 (c)	943.44 (d)	985.08 (c)
3	681.97 (e)	647.988 (f)	665.55 (ef)
6	449.66 (g)	401.2 (h)	469.27 (g)
8	282.82 (k)	227.4 (L)	294.44 (k)

. LSD .05 = 28.75

- Were LSD : The Least Significant Difference

Table 4.1b indicates the significant difference of the yield of the plant under different salinity levels and different soil types. From this table it is clear that there is a significant difference between different levels of salinity for the same type of the soil. Yield was more in clay and loamy soils than in sandy soils for all salinity levels, because sandy soil doesn't retain water as much as the other types of soil.

Table 4.1b Mean Yield under Different Salinity Levels and Different Soil Types.

Salinity	Yield (gm/plant)		
	Clay soil	Loamy soil	Sandy soil
0	1056.24 (a)	1031.267 (a)	1001 (b)
1	990.97 (bc)	970.3 (c)	948.77 (d)
3	670.07 (e)	669.1 (e)	663.7 (e)
6	451.78 (f)	448.7 (f)	418.8 (g)
8	285.73 (h)	280.88 (h)	242.55 (k)

. LSD .05 = 28.75

From table 4.1c which describes the mean yield versus soil type and irrigation level it is clear that the best yield was obtained under Medium irrigation level in the different soil types also in the sandy soil under high irrigation level. Where the presence of sufficient amount of water in the root zone decreases the effect of salinity. It was clear that under low irrigation level , when the plant stress increased, the decrease in the yield was increased and effect of salinity increased.

Table 4.1c Mean Yield of Different Salinity Levels under Different Soil Types and Different Irrigation Levels.

Soil type	Yield (gm/ plant)		
	Medium Irrigation Level	Low Irrigation Level	High Irrigation Level
Soil type 1	699.42 (a)	663.66 (b)	649.78 (b)
Soil type 2	697.31 (a)	657.93 (b)	670.8 (b)
Soil type 3	686.52 (a)	630.64 (c)	673.94 (a)

. LSD .05 = 28.75

From table 4.1d which describes the mean yield versus fertilizer dose and mulch cover, it was clear that mulch cover reduced the effect of salinity on the plant by reducing the evaporation from the soil surface. The use of mulch cover decreases the chance of plant drought, which improve plant response to the salinity effect. There is no significant effect of N & K fertilizers observed at the same salinity level. Effect of P was observed at higher salinity levels were P improved response to salinity, so less reduction in the yield is obtained.

These results agree with the observations of Gibson, (1988) who reported that the requirement for more P in salinized plants could be related to its role in energy fixation and carbohydrate partitioning and transport. Moreover, P is also involved in the synthesis of membrane lipids, which are vital for ionic regulation. NaCl salinity reduced P transport and uptakes in tomato and other plant species. Phosphorus application has increased yield in cereal and pasture species in saline soils at levels of available P sufficient to give maximal yield under normal soil conditions.

Table 4.1d : Mean Yield Under Different Salinity Levels with Different Fertilizers Doses and Mulch Cover.

Salinity	Yield (gm/plant)						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	1014 (c)	1028 (c)	1008 (c)	1008 (c)	1005 (c)	1070 (b)	1141.8 (a)
1	966 (d)	968 (d)	977 (d)	1015 (c)	996 (cd)	1000 (c)	1166 (a)
3	669 (f)	667 (f)	665 (f)	700 (ef)	648 (f)	668 (f)	711 (e)
6	454 (h)	440 (h)	428 (h)	513 (g)	444 (h)	447 (h)	516 (g)
8	292 (l)	293 (l)	251 (m)	310 (l)	283 (l)	280 (l)	306 (l)

. LSD .05 = 40.27

4.1.2 Effect of Salinity on the Relative Yield :

It was shown that the salinity tolerance of different treatments for the same cultivar were determined according to the threshold and slope values (Mass and Hoffman, 1977; Van Genuchten and Hoffman, 1984). Figures (B1--B16) in appendix B show were the relative plant yield versus the average salinity of the soil extract in root zone. These Figures show that the plant tolerance to salinity can be determining by the threshold value and the slope.

As shown in Figure (B16) the highest threshold values (maximum electrical conductivity (EC) value without yield reduction) and lowest slopes (yield decreases per EC increases) of all treatments were obtained with clay soil, medium irrigation level, regular fertilizer (N1, P1, K1) and when the soil was covered with black plastic mulch. The threshold value was (a = 4.5) and the slope was (b =5.8%). This is because the mulch cover prevented water from evaporations from the soil surface, increasing the moisture content of the soil and hence the effect of salinity was lowered. In addition, mulch increased the soil temperature which in turn enhanced root development.

Support for these results come from Cooper (1973) who reported that mulches significantly affect soil temperature and soil physical factors influencing root development– soil temperature is important in determining the rooting volume of a crop and affects root extension, branching, and diameter.

From the slopes of (Figures B1 – B16) it was found that the yield reduction differed among the treatments. Generally the plants in the three types of soil showed maximum reduction in the yield when water content decreased. However, maximum reduction was found when sandy soil used for planting and irrigate with low irrigation level and regular fertilization application (N1, P1, K1) the threshold value (a = 3) and the slope (b = 7.7%). As shown in (Figure B8) this change can be attributed to the nature of the sandy soil, that doesn't retain water, so the reduction in the amount of irrigation water as in this treatment will cause soil dryness and water stress for the plant. This will increase the plant response to salinity which leads to reduction in yield.

Ayers and Westcot, (1989) reported that the crop doesn't respond to extremes of low or high salinity in the root zone depth but integrates water availability and takes water whenever it is most readily available. Irrigation scheduling is thus important in maintaining high soil-water availability and reducing the problems caused, when the crop must draw a significant portion of its water from the less available, higher salinity soil – water deeper in the root zone.

As presented in Figures B3, B6& B9it is shown that in the different soil types(clay, loamy, sandy soil) that when high irrigation level are used in these types of soil(6L/week). The threshold value increased as (4.4, 4.2, 4) respectively and the slope decreased (5.04, 5.9, 6.2 %) which reflects that the tomato plant is more tolerant when we use high irrigation level. However, these increases are not significant to compensate the increase of water amount.

It was found in Figures B11, B13 & B15 that increased nutrients (N, P, K) will increase the tolerance of cherry tomatoes to salinity. The threshold value increase in the case of phosphorus fertilizer increase, it reached (a = 4.2) and the slope decreased to (5.15%). In the case of potassium fertilizer, the threshold value was (a = 4.3) with slope (b = 5.32%). In the case of N fertilizer the threshold value (a = 3.8) with slope (5.62%). This is supported by Satti et al. (1995) who reported that an improvement in fruit weight was obtained when saline solutions were enriched with K, P and Ca.

The increase in K level, however, has favorable as well as adverse effects of salinization on K content as sodium is known for inhibiting uptake of K, possibly due to an antagonistic effect between the two cations.

This compares with the finding by Gibson, (1988) who found that Phosphorus application increases yield in cereal and pasture species in saline soils at levels of available P sufficient to give maximal yield under normal soil conditions. Also Awad, (1990) reported that salinity treatment decreased the concentration of Phosphorus in both the soil solution and plant leaves. These results agree with results found in this research that the increase of Phosphorus fertilizers is very important as it decreases the salinity effect on the plant production as presented in Figure (B13).

Locasico et al. (1974) agree with the result of this study in reporting that tomatoes have responded with increased production with N and K injected into the irrigation water in contrast preplanting application.

Also Awad, (1990) reported that the addition of certain elements to the saline soil might correct the deficiency symptoms that occurred due to salinity. The addition of P, K and Ca resulted in a positive effect on plant mineral uptake.

From Figures (D1 – D16) we can observe the production of cherry tomato versus time through the season period, The results indicate the following:

- At low salinity levels (0&1gm) there was an increase in fruit yield with time up to a maximum yield by mid. seasons then a yield decrease acceptable levels.
- The maximum yield reached at low salinity levels, was not noticeably affected by the various treatments
- At medium salinity treatment levels (salt level 3gm/ kg) the fruit yield also increased but with much lower rates.
- At high salinity levels (salt level 6,8gm/ kg) the increase in fruit yield was not clear and almost steadies amount.

4.2 Effect of Salinity on Fruit Size: -

To evaluate the effect of salinity on fruit size, the fruit no./100gm of fresh weight was used as an indicator of fruit size. It was found that as salinity increased the fruit became smaller as fruit no./100gm increased (Table 4.2a). It is clear that the reduction of yield as the salinity increase is not due to the fruit no./plant but due to the reduction of the fruit weight as the salinity increased.

The results presented in Table 4.2a indicate significant differences between different salinity levels and water irrigation. It is clear that under high salinity levels with medium irrigation level, the largest fruit no./100gm (16.6) was observed. This indicates that these blocks have the smaller fruit. It was found also that with the different salinity levels and using medium irrigation level the fruit no./100gm have the largest means, which indicates that the means are smaller in all salinity levels compared with other irrigation levels.

Table 4.2a : Mean Fruit No./100gm Under Different Salinity Levels and Different Irrigation Levels.

Salinity	Fruit No./100g		
	Medium Irrigation Level	Low Irrigation Level	High Irrigation Level
0	6.73 (h)	7.92 (g)	6.5 (h)
1	6.626 (h)	6.63 (h)	6.44 (h)
3	10.45 (ef)	11.15 (e)	10.15 (f)
6	13.56 (c)	14.05 (c)	12.93 (d)
8	15.82 (b)	16.66 (a)	15.7 (b)

. LSD .05 = 0.79

From Table 4.2b it may be observed that there is a significant difference between different levels of salinity under different soil types, but it is also apparent that the fruit no./100gm in the sandy soil has the largest no, which indicates that it has the smallest fruit. These results are supported by yield production for sandy soil and at low irrigation level where yield in this treatment shows the lowest values. This is because the fruit yield reduction was associated with a reduction in the weight per fruit rather than the number of fruits per plant.

Table 4.2b : Mean Fruit No./100gm Under Different Salinity Levels and Different Soil Types.

Salinity	Fruit No./100g		
	Clay soil	loamy soil	Sandy soil
0	6.34 (g)	6.69 (g)	8.116 (f)
1	6.59 (g)	6.506 (g)	6.56 (g)
3	10.18 (e)	10.32 (e)	11.6 (d)
6	13.2 (c)	13.46 (c)	13.88 (c)
8	15.7 (b)	15.85 (b)	16.78 (b)

. LSD .05 = 0.79

There is no significant interaction between soil and water treatment so soil type and water level treatments can be ranked according to their effect on the fruit no./100g as shown in Tables 4.2c & 4.2d.

Table 4.2c : Mean Fruit No./ 100gm of Different salinity level Under different soil Types

Rank	Soil type	Mean
1	Sandy soil	11.4066 a
2	Loamy soil	10.58 b
3	Clay soil	10.4511 b

. LSD .05 = 0.2315

Table **4.2d : Mean Fruit No./ 100gm Under different Irrigation Levels**

Rank	Irr. Level	Mean
1	Low irrigation Level	11.66 a
2	Medium irrigation Level	10.653 b
3	High irrigation Level	10.377 c

. LSD .05 = 0.225

From Table 4.2e it was found that there is a significant difference in the different salinity levels. But in the same salinity level it was found that in case of Phosphorus fertilizers it shows the largest fruit number and mulch cover show the smallest fruit number/ 100 gm fruit weight.

Table 4.2e : Mean Fruit no./100 gm Under Different Salinity Level with Different Fertilizer Doses and Mulch Cover.

Salinity	Fruit no./ 100gm						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	6.3 (l)	6.63 (l)	5.3 (m)	6.03 (l)	6.6 (l)	6.6 (l)	5.46 (m)
1	6.4 (l)	5.9 (lm)	6.3 (l)	6.66 (l)	6.7 (l)	6.65 (l)	6 (l)
3	10.5 (g)	10 (g)	10.8 (g)	11.9 (f)	10.1 (g)	10.7 (g)	9.5 (h)
6	12.5 (e)	12.66 (e)	13.4 (de)	14 (d)	13 (e)	13.3 (de)	12.5 (e)
8	15.7 (b)	16.36 (b)	16.2 (b)	17.2 (a)	16 (b)	16.4 (b)	15.2 (c)

. LSD .05 = 0.8235

4.2.1 Comparison with Published Results:

A comparison between published results found in literature and those obtained in this study show the following:

The result of this research agree with the finding of Usherwood, (1985) that salinity reduces tomato yield, mainly by affecting its fruit weight. On the other hand, salt tolerance seems to be connected with the plant's ability to increase the concentration of solutes in its tissue.

Previous work has found that increased salinity lowers the yield (Kg/plant) due to smaller and fewer fruit (Willumsen et al., 1996), the latter being less important than the fruit size. The equatorial diameter of salinized fruits was also reduced between 6 and 16% compared with control fruits, but only high salinity changed the commercial grades from (45-57mm) to (<47mm) Balibrea et al., 1997.

Gough and Hobson, 1990 found that with cv. Gardeners Delight, there is no loss in total crop weight in the conditions used with salinity values up to 5 dS m^{-1}, but with benefit to the fruit size so that considerably limit to 35 mm diameter.

Matinez et al., 1987 reported that yield parameters progressively decreased as salinity increased in all tomato hybrids, as well as a significant hybrid effect. Fruit yield reduction was associated with a reduction in the weight per fruit rather than to the number of fruits per plant. These finding, agree with the finding of our study.

Rylski et al, (1987) reported that the cause of decrease in yield due to salinity was a reduction in fruit size rather than in fruit number. In effect, this led to an increase in the percent of fruit in the 20-30 mm diameter range, which is the required size of export quality cherry tomatoes. Furthermore, total yield of export size tomatoes was higher under the saline treatments, as compared to the control, despite the decrease in total yield.

Balibrea et al (1997) reported that both fruit number and weight determine the fruit yield of a tomato plant. It is well known that salinity decreases tomato yield above 2.5 - 3 dS m^{-1} of EC in the extract. This result agree with the finding of our experiment that at moderate salinity, fruit yield is more affected by the fruit weight than by the their number, while at high salinity, both parameters are affected.

4.3 Effect of Salinity on Titrable Acid:

The concentration of titrable acid expressed in gm citric acid per 100 gm fresh weight was used to evaluate the effect of salinity on fruit titrable acid. It was found that the concentration of titrable acid increased as salinity increased, as presented in Table 4.3a.

Because the sugars and organic acids account for the major portion of the tomato total soluble solids, most research concerning tomato quality has centered on these components. It was observe that there is significant difference between different levels of salinity for the different treatments.

But there is no significant difference among the different treatments at the same salinity level, and there is no significant interaction between these treatments. Each treatment will thus be ranked according to its effect on the titrable acid.

Table 4.3a : Mean Titrable Acid of Different Salinity Levels Under Different Salinity Levels.

Rank	Salinity level	Mean
1	8g	0.9133 a
2	6g	0.8466 b
3	3g	0.7577 c
4	1g	0.6459 d
5	0	0.555 e

. LSD .05 = 0.0141

From Table 4.3b it is show that there is significant difference between low irrigation level and irrigation levels of medium & high, as with low irrigation level the mean of titrable acid ranked the largest value.

Table 4.3b : Mean Titrable Acid of Different Salinity Levels Under Different Irrigation Levels.

Rank	Irr. Level	Mean
1	Low irrigation level	0.75222 a
2	Medium irrigation level	0.74 b
3	High irrigation level	0.73933 b

. LSD .05 = 0.011843

For the soil type effect on the titrable acid it was clear from Table 4.3c that in the sandy soil the mean value of the titrable acid has the largest value .

Table 4.3c : Mean Titrable Acid of Different Salinity Levels Under Different Soil Type.

Rank	Soil type	Mean
1	Sandy soil	0.7704 a
2	Loamy soil	0.7377 b
3	Clay soil	0.7233 c

. LSD .05 = 0.013668

In contrast, for the fertilizer treatments and mulch cover, from Table 4.3d it was found that there is a minor significant effect due to fertilization treatments. It was found that addition of phosphorus & potassium fertilizers has a significant effect on the titrable acid, Similar thing for the mulch cover.

Table 4.3d : Mean Titrable Acid of Different Salinity Levels Under Different Fertilizer Doses and Mulch Cover .

Rank	Treatment	Mean
1	K3	0.764 a
2	Mulch cover	0.764 a
3	P3	0.76133 a
4	K2	0.74866 ab
5	P2	0.74466 b
6	N3	0.738 b
7	N2	0.736 b

. LSD .05 = 0.0158

4.3.1Comparison with Published Results:

In comparison with published results found in literature with those obtained in this study the following was observed:

Mizrahi and Pasternak, (1985) reported that the juice of ripe processing tomatoes from plant exposed to increasing degrees of salinity showed increases in TSS content, total acidity, and electrical conductivity.

The acidity of the fruit juices always increased with salinity and these results agree with our research findings (Adams and Hobson, 1989). If the source of salinity increases the concentration of K in the fruit, acid production is further stimulated.

The finding of (Balibrea et al., 1997) are not in agreement with our results. He reported that the citric and malic acids were more abundant organic acids in pericarp tissue and their contents were reduced by 24 and 41% respectively under high salinity. The citric acid contents were 2-3 times higher than the malic acid ones. As the last was more affected by salinity, the citric /malic ratio increased from 2.7 (control) up to 3.5.

Mizrahi and Pasternak (1985)reported that their unpublished data show that irrigating such tomato plants with saline water for two weeks before the expected time of ripening will increase the TSS and acid contents.

Martinze, et al. (1987) reported that the total soluble solids and titrable acidity increased with increasing salinity in all tomato hybrids.

4.4 Effect of Salinity on the fruit pH:

To evaluate the effect of salinity on the fruit quality parameters its effect on the fruit pH was observed in this study. It was found that salinity has no significant effect on the pH of fruit sap in all treatments and at all salinity levels, and that there is no interaction between different treatments. (see Table 4.4a).

Table 4.4a : Mean fruit pH of Different Salinity levels Under Different Salinity levels.

Rank	Salinity level	Mean
1	0g	4.171 a
2	6g	4.055 a
3	8g	4.039 a
4	3g	3.984 a
5	1g	3.9811 a

. LSD .05 = 0.2823

For the effect of irrigation level and the soil type on the pH values it is apparent from Tables 4.4b & 4.4 c that there is no significant difference due to the irrigation level and soil type on the fruit pH.

Table 4.4b : Mean Fruit pH of Different salinity levels Under Different Irrigation Levels.

Rank	Irr. Level	Mean
1	High irrigation level	4.1213 a
2	Medium irrigation level	4.04022 a
3	Low irrigation level	3.977 a

. LSD .05 = 0.2372

Table 4.4c: Mean Fruit pH of Different Salinity Levels Under Different Soil Types.

Rank	Soil type	Mean
1	Sandy soil	4.15111 a
2	Clay Soil	4.01022 a
3	Loamy soil	3.97755 a

. LSD .05 = 0.32988

For the effect of fertilizers and mulch cover, from the statistical analysis it was found that there is no trend in the pH value due to different treatments. So a minor significant effect of these different treatments was found on the pH values.

Table 4.4d: Mean pH Values Under Different Salinity Levels with Different Fertilizer Doses and Mulch Cover.

Salinity	PH						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	4 (f)	4.02 (e)	3.95 (f)	3.99 (f)	3.97 (f)	3.95 (f)	3.98 (f)
1	4.02 (e)	4.04 (bc)	3.95 (f)	3.98 (f)	3.99 (f)	3.96 (f)	3.96 (f)
3	4.03 (d)	4.09 (a)	4.02 (e)	4.02 (e)	4.01 (ef)	4 (f)	4 (f)
6	4.2 (e)	4 (f)	4.05 (c)	4.02 (e)	4 (f)	4.02 (e)	4.04 (bc)
8	4.06 (b)	4.08 (a)	4.02 (e)	4.01 (ef)	4.02 (e)	4.02 (e)	4.03 (d)

. LSD .05 = 0.0217

4.4.1Comparison with Published Results:

In comparison with published results found in literature with those obtained in this study the following was observed:

Mizrahi and Pasternak, (1985) reported that the pH of the juice of ripe tomato was not changed significantly, except at the highest salinity, where it was reduced, we are agree with the result which indicate that pH was not changed significantly with salinity treatments. But we are not agree with their result which indicate that as salinity increase the pH decrease. We found that the pH levels were between 3.9 – 4.06.

(Balibrea et al., 1997) reported that the pH of the whole fruit under different levels of salinity was always about 4.

(Satti and Al-Yahyai, 1995) found that the applied salinity treatments have shown no effect on pH of tomato plants.

Shalhevet and Yaron, 1973 reported that the mean pH of tomato juice was 4.3 with no meaningful differences among treatment.

(Martinez et al., 1987) reported that the pH of the tomato juice was not affected either by salinity or hybrid. The pH mean values ranged from 4.09 to 3.9

4.5 Effect of Salinity on the Total Soluble Solids (TSS) :

In evaluating the effect of saline water for irrigation of cherry tomatoes versus fruit quality, Total Soluble Solids (TSS) was evaluated.

It was found that there is a significant difference on the titrable acid with the different level of salinity (Table 4.5a). As salinity increased the total soluble solid (TSS) increased, which indicates that salt stress could improve the quality of tomato fruits in terms of the concentration of total soluble solids (TSS).

Table 4.5a : Mean (TSS) Values under Different Salinity Levels.

Rank	Salinity level	Mean
1	8g	8.322 a
2	6g	7.907 b
3	3g	7.2889 c
4	1g	6.488 d
5	0g	5.733 e

- LSD .05 = 0.186

In addition to the salinity effect, the different irrigation treatments exhibit significant difference on the values of the TSS. From Table 4.5b it was found that low irrigation level has the largest increase in the TSS because as mentioned before, salt stress improves the fruit taste by increasing the (TSS). Thus as the irrigation level are decreased the salt effect and stress on the plant increases.

Table 4.5b : Mean (TSS) Values of Different Salinity Levels under Different Irrigation Levels.

Rank	Irr. Level	Mean
1	Low irrigation level	7.5311 a
2	Medium irrigation level	7.0711 b
3	High irrigation level	6.8422 c

. LSD .05 = 0.16455

However there is no significant difference with the different type of soil as presented in Table (4.5c).

Table 4.5c: Mean (TSS) Values of Different Salinity Levels under Different Soil Types.

Rank	Soil type	Mean
1	Clay soil	7.1644a
2	Loamy soil	7.1555a
3	Sandy soil	7.1244a

. LSD .05 = 0.3875

Although the different doses of fertilizers show minor significant differences as presented in Table (4.5d), it was found that the use of K3 fertilizers has the largest increase in the TSS. As potassium was the third macronutrient required for plant growth. Concentration of this nutrient in plants typically ranges between 1 and 4 to 5%, but it can be somewhat higher. Also it is important in translocation of assimilates as the plant's transportation system uses energy in the form of ATP- which requires potassium for its synthesis. The translocation of sugar from leaves of sugarcane is greatly reduced in potassium – deficit plants (Tisdale et al., 1985).

Table 4.5d: Mean (TSS)Valued of Different Salinity Levels under Different Fertilizer Doses and Mulch Cover.

Rank	Treatment	Mean
1	K3	7.3 a
2	Mulch cover	7.18 ab
3	P3	7.02 b
4	P2	6.9866 b
5	N2	6.96 b
6	K2	6.92 b
7	N3	6.6533c

- LSD .05 = 0.25899

4.5.1 Comparison with Published Results:

In comparison with published results found in literature with those obtained in this study the following was observed:

Martinze, et al. (1987) reported that the total soluble solids and titrable acidity increased with increasing salinity in all tomato hybrids. Salt stress could improve the quality of tomato fruits in terms of the concentration of total soluble solids (Cornish, 1992).

Rylski, et al., (1987) reported that in addition to the positive effect of salinity on the soluble solids content, a major parameter of fruit quality.

Mizrahi and Pasternak, (1985) reported that the juice of ripe processing tomatoes from plant exposed to increasing degrees of salinity showed increases in TSS content, total acidity, and electrical conductivity.

Pasternak, Twersky and De Malach, (1979) reported that when salt tolerant, edible crops are grown under saline conditions, the flavor of the product, although often at the expense of marketable yield. Salt tolerance seems to be linked with an ability to increase the concentration of solutes in plant tissues.

4.6 Effect of Salinity on Vitamin C Concentration of the Fruit:

Another quality parameter evaluated in this experiment was vitamin C (where the vitamin C concentration expressed as weight of total ascorbic acid in mg per 100 gm fresh weight).

It was found that there is a significant difference in the vitamin C concentration among the different levels of salinity (table 4.6a). The concentration of vitamin C increased as the salinity level increased. This result agrees with the finding of (Petersen et al., 1998) that vitamin C concentration expressed as mg total ascorbic acid per 100 g fresh weight increased with salinity.

Table 4.6a : Mean Vitamin C Concentration of Different Salinity Levels under Different Salinity Levels

Rank	Salinity level	Mean
1	8g	23.114a
2	6g	21.359b
3	3g	20.490c
4	1g	19.742d
5	0g	19.168e

. LSD .05 = 0.195

Table (4.6b) represents the effects of soil interaction with the salinity effect. Minor difference observed, that the higher concentration value found in sandy soil with high salinity level (8gm/kg).

Table 4.6b Mean Vitamin C Concentration under Different Salinity Levels and Different Soil Type

Salinity	Vitamin C Concentration /mg		
	Clay soil	Loamy soil	Sandy soil
0	19.266 (e)	19.3 (e)	19.2 (e)
1	19.64 (e)	19.775 (e)	19.725 (e)
3	20.11 (de)	20.368 (de)	20.59 (d)
6	21.27 (cd)	21.6 (c)	21.56 (c)
8	22.433 (b)	23.06 (b)	23.96 (a)

. LSD .05 = 0.83

For the effect of irrigation level it is observed that there are minor significant differences among irrigation level as presented in

Table(4.6c).From this table it was found that at low irrigation level the vitamin C has its largest value. As (Zushi and Matsuzoe, 1998) found that the effect of soil water deficit on vitamin C content per fresh weight varied, depending on the cultivars, in some cultivars vitamin C content increased as with our experiment, whereas in others it was not affected

Table 4.6c : Mean Vitamin C Concentration of Different Salinity Levels under Different Irrigation Levels

Rank	Irrigation Level	Mean
1	Low irrigation level	20.9577a
2	High irrigation level	20.7102b
3	Medium irrigation level	20.6575b

. LSD .05 = 0.1869

For the effect of fertilizers doses & mulch cover on vitamin C content of the fruit it is apparent that as salinity increases with different treatment the vitamin C concentration increases, but the higher values were observed when N3 fertilizers doses were applied, Table(4.6d).

Table 4.6c : Mean Vitamin C Concentration/ mg Under Different Salinity Levels with Different Fertilizer Doses and Mulch Cover.

Salinity	Vitamin C Concentration /mg						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	19.3 (hl)	19.2 (hl)	19.2 (hl)	19.4 (h)	18.95(l)	19 (l)	19.1 (l)
1	19/8 (g)	20 (g)	19.95(g)	19.9 (g)	19.85(g)	19.84(g)	20 (g)
3	20.7(ef)	20.88(e)	20.95 (e)	20.7 (ef)	20.8 (ef)	20.9 (e)	20.65 (f)
6	21.5 (d)	21.8(cd)	21.8(cd)	21.86 (c)	21.6(cd)	21.7(cd)	21.6 (cd)
8	23.2(ab)	23 (b)	23.3 (a)	23.2(ab)	23 (b)	23.4 (a)	23.2 (ab)

. LSD .05 = 0.233

In agreement with other investigations, the concentrations of dry matter, sugars, titrable acid and vitamin C increased with salinity increased when calculated on the basis of fresh weight (Adams and Ho. 1989;Adams, 1991)

4.7 Effect of Salinity on Reducing Sugars:-

Reducing sugars (fructose/glucose) is one of the most important quality parameter in that it affects the flavor of the fruit. Reducing sugar content was measured in this experiment.

It was observed that there is a significant difference between the different levels of salinity in the different type of soil (table 4.7a), but for the same salinity level of different types of soil there is no signifficnt difference.

Table 4.7a Mean Reducing Sugar Concentration under Different Salinity Levels and Different Soil Type

Salinity	Reducing Sugar Concentration /mg		
	Clay soil	Loamy soil	Sandy soil
0	3.4077 (e)	3.45 (e)	3.446 (e)
1	3.623 (de)	3.708 (d)	3.782 (cd)
3	3.897 (c)	3.96 (c)	3.977 (c)
6	4.1744 (bc)	4.2 (b)	4.282 (b)
8	4.4266 (ab)	4.5 (a)	4.55 (a)

. LSD .05 = 0.2045

For the irrigation level and salinity level (table 4.7b) it is obvious that there is a significant effect due the salinity level but there is no significant effect among the different water levels.

Table 4.7b: Mean Reducing Sugar Concentration under Different Salinity Levels and Different Irrigation Level.

Salinity	Reducing Sugar Concentration /mg		
	Medium irrigation level	Low irrigation level	High irrigation level
0	3.3667 (e)	3.582 (de)	3.388 (e)
1	3.684 (d)	3.73 (d)	3.711 (d)
3	3.9166 (c)	3.998 (c)	3.9188 (c)
6	4.2022 (b)	4.25 (b)	4.197 (b)
8	4.4522 (a)	4.6 (a)	4.428 (a)

. LSD .05 = 0.2045

For the interaction effect of the soil type and irrigation level on reducing sugar it was apparent from Table (4.7c) that there is a minor significant effect due to the different treatments, as with low irrigation level in the three soil types it is ranked as the highest value.

Table 4.7c Mean Reducing Sugar Concentration under Different Soil Types and Different Irrigation Levels.

Soil type	Reducing Sugar Concentration /mg		
	Medium irrigation level	Low irrigation level	High irrigation level
Soil type 1	3.87 (b)	3.96 (a)	3.877 (b)
Soil type 2	3.9066 (a)	4.038 (a)	3.951 (a)
Soil type 3	3.988 (a)	4.08 (a)	3.957 (a)

. LSD .05 = .2045

From Table (4.7d) it was observed that the effect of salinity interact with different fertilizers doses and mulch cover. As it was found that there is a significant difference due to the salinity levels as the reducing sugar has increased in a large value in high salinity levels in all treatments. Also increase the fertilizers with high salinity increase the reducing sugar concentration.

Table 4.7d: Mean Reducing Sugar Concentration Under Different Salinity Levels with Different Fertilizer Doses and Mulch Cover.

Salinity	Reducing sugar Concentration /mg						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	3.4 (f)	3.38 (f)	3.45 (f)	3.39 (f)	3.42 (f)	3.4 (f)	3.41 (f)
1	3.8 (e)	3.85 (e)	3.78 (e)	3.78 (e)	3.8 (e)	3.85 (e)	3.82 (e)
3	3.96 (d)	4 (d)	3.98 (d)	4.02 (d)	3.92 (de)	3.98 (d)	3.97 (d)
6	4.23 (c)	4.31 (c)	4.32 (bc)	4.35 (bc)	4.34 (bc)	4.39(bc)	4.33(bc)
8	4.42 (b)	4.54 (a)	4.5 (ab)	4.58 (a)	4.52 (ab)	4.57 (a)	4.5 (b)

- LSD .05 = 0.033

4.7.1 Comparison with Published Results:

In comparison with published results found in literature with those obtained in this study the following was observed:

Gough and Hobson, (1990) agreed with our results that high salinity confers good quality and flavor to cherry tomatoes by increasing the sugar content

Satti et al.(1995) reported a significant correlation between overall flavor intensity and citric acid and fructose content, as well as the glucose – citric acid in trebly. The highest overall flavor intensity was found in samples where both sugar and titrable acid contents were high. Addition of reducing sugars (fructose/glucose) and citric acid to fresh tomatoes improves the flavor acceptability of the product significantly (Malundo et al., 1995).

(Balibrea et al., 1997) reported that the best quality attributes on postharvest tomatoes were obtained under moderate saline conditions, because the greatest concentration of fructose, glucose, citric acid and soluble proteins were found there. This result is not in agreement with our result that reducing sugar increase also at high salinity.

Although (Martinez et al., 1987) are not in agreement with our results, they reported that the effect of the salinity treatment on percent of glucose was much less consistent since it only increased at intermediate salinity levels.

Alfocea et al. (1993)reported that the concentration of glucose, fructose and soluble solids in g per 100g fresh weight increased significantly with salinity. If calculated per 100 g dry matter the concentrations of glucose and soluble solids also increased significantly with salinity.

(Zuushi and Matsuzoe,1998) reported that the amount of glucose and fructose per fresh weight in water – stressed plants were larger than those of control treatment in almost all cultivars, but they were the same on dry weight basis. This is indicates that water deficit merely reduced water accumulation.

4.8 Effect of Salinity on the Vegetative Growth:

The effect of salinity on the vegetative growth was conducted by measuring the length of the plant every 10 days, dry matter of the shoot and dry matter of the root at the end of season.

4.8.1 Effect of Salinity on the Plant Length :

From (Table 4.8.1a) it was observed that there is a significant effect on plant length under the different salinity levels. That as the salinity increases plant growth is suppressed by reducing stem elongation, so it was found that there is a decrease in the plant elongation as the salinity increased .This may be attributed to osmotic potential in water availability or specific ion effect.

Saline water irrigation effect on these vegetative growth parameters will be discussed in the following sub sections.

Table 4.8.1a : Mean Plant Length under Different Salinity Levels.

Rank	Salinity level	Mean
1	0g	276.148 a
2	1g	247.222 b
3	3g	215.962 c
4	6g	177.629 d
5	8g	167.481 e

. LSD .05 = 4.236

For the effect of irrigation levels and its interaction with salinity it was found that the effects of salinity were more apparent in low irrigation level

(Table 4.8.1b). As the amount of water reduced the plants were more exposed to drought conditions and the plant were stressed, resulting in reduction of the plant elongation.

Table 4.8.1b : Mean Plant Length under Different Salinity Levels and Different Irrigation Levels.

Salinity	Plant Length/cm		
	Medium irrigation level	Low irrigation level	High irrigation level
0	272.7 (a)	275 (a)	280.64 (a)
1	250.1 (b)	235.4 (c)	256 (b)
3	225.8 (d)	205.9 (e)	221.5 (d)
6	181.3 (f)	171.66 (f)	179.8 (f)
8	183.7 (g)	158.9 (h)	169.95 (gh)

. LSD .05 = 13.6

For the soil type effect it was found that there is significant difference between the three types of soil (Table 4.8.1c) as it was found that the higher values of the plant length was found in the clay soil, and the lowest value was found in the sandy soil because in the sandy soil the plant was exposed to drought conditions and stress more than the other two soil types.

Table 4.8.1c : Mean Plant Length of Different Salinity Levels under Different Soil Types.

Rank	Soil type	Mean
1	Clay soil	221.533 a
2	Loamy soil	216.266 b
3	Sandy soil	212.866 c

. LSD .05 = 2.5401

For the effect of different levels of fertilizers and mulch cover (see Table 4.8.1d). A minor effect on plant length was observed. The higher value of plant length was found in the treatment of mulch cover, this because mulch cover reduced the effect of salinty by reducing the evaporation from the soil surface. Another benefit of the mulch was to increase the soil temperature. The lowest value was observed in the case of k2 where the potassium fertilizer has observed to be very important in reducing the effect of salinity. Plants that are potassium deficient is less able to withstand water stress, mostly because of their inability to make full use of available water.

Table 4.8.1d: Mean Plant Length Under Different Fertilizer Doses and Mulch Cover.

Rank	Treatment	Mean
1	Mulch cover	243.6 a
2	P2	230.466 b
3	N3	228.66 b
4	N1	228.4 bc
5	P3	225.53 bc
6	K3	225.13 bc
7	K2	220.8 c

- LSD .05 = 7.079

The results of the study of the plant length during the growing season were plotted as the plant length versus time as Figures (C1- C16) which indicate the following :

- At low salinity level there was an increase in plant length during the growing season but this increase has more noticeable at the end and mid season than at the beginning of the growing season.
- With high salinity levels it is clear that as plant age increases it's length in cm increases within 10 days decreases.
- The increase in plant length at the low salinity levels is more noticeable in all growing periods compared to high levels of salinity.
- The maximum plant length reached at low salinity levels was in the treatment of mulch cover.

- At medium salinity treatment levels the plant length increased at much lower rates than low salinity levels and at steadies rate.

4.8.1.1Comparison with Published Results:

In comparison with published results found in literature with those obtained in this study the following was observed:

Satti et al., (1995) reported that with tomato plants, stem height was significantly reduced when NaCl was used without the addition of other mineral elements to the saline treatment, and this result agrees with the finding of this experiment especially in the case of reducing the amount of potassium fertilizers were in this case it retard the plant elongation.

Satti and Lopez (1994) found that stem height of tomato was reduced by salinity (50mM NaCl) by 11% but was increased by 6% with the application of 4mM K. When K level increased to 8 and 16 mM, stem height decreased by 5 and 8%, respectively. Leaf number was not found to be significantly affected by salinity and K. Suppression of plant growth under saline condition is shown by reduced stem height, fruit size, and whole plant dry weights compared to control plants. This reduction could be attributed to osmotic reduction in water availability or to specific ion effect particularly Na and Cl. The high amount of Na in saline nutrient solution could have impaired the hydraulic conductivity or permeability of root to water and the displacement of K at the exchange sites in the root thus rendering it less available to the plant possibly resulting in K deficiency .

4.8.2 Effect of Salinity on the Shoot dry Matter:

Shoot dry matter was calculated by dividing of the dry weight of the shoot over the fresh weight of the shoot. From Table (4.8.2a) it was found that there is a significant difference due to the different levels of salinity. As the salinity increased the dry matter of the shoot increased, but the important thing to note is that the fresh weight of the plant decreased as the salinity increased, even as the ratio of the dry weight over the fresh weight (dry matter shoot) increased as the salinity increased.

Table 4.8.2a: Mean Dry Matter Shoot under Different Salinity Levels

Rank	Salinity level	Mean
1	8g	20.92 a
2	6g	19.82 b
3	3g	18.61 c
4	1g	16.174 d
5	0g	14.66 e

- LSD .05 = 0.47558

For the effect of the irrigation water level it was found that there was no significant effect on the shoot dry matter due to the different level of irrigation Table (4.8.2b). For the soil effect it was found that there was a minor effect on the dry matter as the soil type differed, (see Table 4.8.2c) where the lowest value observed in the clay soil.

Table 4.8.2b: Mean Dry Matter Shoot of Different Salinity Levels under Different Irrigation Levels.

Rank	Irrigation level	Mean
1	Low irrigation level	18.2346 a
2	High irrigation level	18.027 a
3	Medium irrigation level	17.862 a

- LSD .05 = 0.43599

Table 4.8.2c: Mean Dry Matter Shoot of different salinity levels under Different Soil Types.

Rank	Soil type	Mean
1	Sandy soil	18.2955 a
2	Loamy soil	18.1895 a
3	Clay soil	17.639 b

- LSD .05 = 0.508

From Table (4.8.2d) the effect of different type of fertilizers addition and mulch cover interactions with the salinity effect was observed for the dry shoot matter. From this table it was observed that the high ratio for the dry matter was found under k3 and p3 fertilizers addition, and the lowest value was obtained under mulch cover and N3 where the vegetative growth was high which caused a reduction in this ratio.

Table 4.8.2d Mean Dry Shoot Matter under Different Fertilizer Doses, Mulch Cover and Salinity Levels.

Salinity	Dry matter shoot						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	14.5 (m)	13.24 (k)	13.9 (n)	14.5 (m)	14.2 (mn)	15.15 (l)	13.5 (n)
1	16.25 (gh)	15.32 (l)	16.5 (g)	17.2 (f)	17 (f)	16.3 (gh)	16 (h)
3	19.2 (cd)	18.7 (de)	19.8 (c)	19 (d)	19.17(cd)	19.7 (c)	18.5 (e)
6	20.15 (b)	19.35(cd)	19.84 (b)	19.5 (c)	20 (b)	20 (b)	19.29(cd)
8	20.27 (b)	20 (b)	20.65 (a)	20.8 (a)	20.5 (b)	20.8 (a)	20.1 (b)

- LSD .05 = .478

4.8.3 Effect of Salinity on the Root Dry Matter:

The same trend was observed in the dry matter of the root as present in Table (4.8.3a), that the dry weight of the root decreased as the salinity increased but the dry matter of the root increase as salinity increase because the fresh weight of the plant decrease.

In Table (4.8.3a) it was observed that there is significant difference in the dry matter of the root at the different level of salinity and we found that in the sandy soil were the dry matter of the root has the largest value because as said before in the soil type 3 the fresh weight reduced.

For the effect of irrigation level with salinity effect on the dry matter of the root it was observed that the largest value was obtained in the low irrigation level.

Table 4.8.3a: Mean Dry Matter Root of different salinity levels under Different Salinity Levels and Different Irrigation Levels.

Salinity	Dry matter root		
	Medium irrigation level	Low irrigation level	High irrigation level
0	18.266 (g)	18.4167 (g)	17.833 (h)
1	19.167 (f)	19.467 (f)	19.11 (f)
3	20.18 (e)	20.89 (d)	20.35 (e)
6	21.383 (c)	21.8 (c)	21.56 (c)
8	22.7 (b)	23.2 (a)	22.75 (b)

- LSD .05 = .484

Table 4.8.3b: Mean Dry Matter Root Under Different Salinity Levels and Different Soil Types.

Salinity	Dry matter root		
	Clay soil	Loamy soil	Sandy soil
0	17.83 (l)	17.76 (l)	18.9 (f)
1	19 (f)	18.967 (f)	19.78 (e)
3	20.44 (d)	19.68 (e)	21.29 (c)
6	21.433 (c)	21.083 (c)	22.233 (b)
8	22.45 (b)	22.633 (b)	23.566 (a)

- LSD .05 = 0.484

For the effect of soil type and irrigation level (table 4.8.3c) it was found that the maximum value was obtained under low irrigation level and soil where the vegetative growth was retarded due to this treatments.

Table 4.8.3c: Mean Dry Matter Root under Different Soil Types and Different Irrigation Levels.

Soil type	Dry matter root		
	Medium irrigation level	Low irrigation level	High irrigation level
Soil type 1	20.248 (c)	20.49 (c)	20.3 (c)
Soil type 2	20.03 (c)	20.25 (c)	19.8 (c)
Soil type 3	20.94 (b)	21.524 (a)	20.9 (b)

- LSD .05 = 0.484

(Rodriguez et al., 1997) agreed with our result as they reported that the dry weight (leaves, steam and root) were clearly lower in the saline treatment than in the control. However, the shoot ratio increased in salt treated plants, indicating that there was a very substantial reduction in root growth under saline conditions and that root quantity and distributions as well as hydraulic conductivity determine shoot development.

From Table 4.8.3d it was found that under high salinity with mulch cover, P3 and K3 treatment its found that the root dry matter has the largest value.

Table 4.8.3d Mean Dry Root Matter Under Different Fertilizer Doses, Mulch Cover and Salinity Levels.

Salinity	Dry matter shoot						
	N2	N3	P2	P3	K2	K3	Mulch cover
0	18 (n)	17.9 (n)	17.9 (n)	18.5 (m)	18.24 (n)	18.8 (m)	18.7 (mn)
1	19 (l)	19.5 (h)	19.6 (h)	19.35 (h)	19.2 (l)	19.5 (h)	19 (l)
3	20.5 (fg)	20 (g)	19.8 (gh)	19.95 (g)	19.97 (g)	20.15 (g)	20.1 (g)
6	21.8 (de)	21.5 (e)	21.8 (de)	21.45 (e)	21.85 (de)	22.32 (cd)	22.25 (cd)
8	22.4 (c)	22 (d)	22.15 (cd)	22.82 (b)	22.5 (bc)	23 (ab)	23.2 (a)

- LSD .05 = .478

(Satti and Al-Yahyai,1995) reported that salinity treatments affected the vegetative growth of the tomato cultivars as there were significant differences in stem and leaf dry weight between control plants and other treatment with salinity. The lowest dry weight in vegetative parts were obtained when NaCl and P were applied. The root dry weight were not significantly different among the applied salinity treatment.

Summary and Conclusion

5. Summary and Conclusion

The increasing demands on the national limited water resources make urgent broad scale planning and sound decision making to enhance development of all the water resources in the state, including those with inferior quality as saline water and sewage. This urgency is super imposed upon important economic and scientific considerations.

In studying the effect of salinity on cherry tomato under various irrigation, soil types, fertigations and mulch cover it was found that: -

- Cherry tomato plant tolerance increased with the use of mulch cover as it decreased the evaporation from the soil surface. It was found that the threshold value (a = 4.5) and the slope (b = 0.05846).
- Sufficient fertilizer should be added to the plant to reduce the effect of salinity on the plant, as the plant tolerance increases with increasing phosphorus and potassium fertilization. Where the threshold value of the yield in the case of phosphorus fertilizers addition was (a = 4.2) and (a = 4.3) in the case of Potassium fertilizers addition.
- Fruit quality parameter improved as a result of salinity increase in the soil including TSS, Vitamine C, Reducing sugar, Titrable acid. Where the pH of the fruit Juice didn't change as the salinity increases.

- The plant vegetative growth of the plant reduced as the salinity increase. It was found that in the treatment of sandy soil, low irrigation level, N1-P1K1 and high salinity (8gm salt addition per kg soil) the plant length was the least value (156.6 cm) at the end of the growing season. The maximum values of the plant length in all the salinity levels were found in the treatments of clay soil, medium irrigation level, regular fertilizers doses addition (N1-P1-K1)and mulch cover.
- The dry weight of the shoot decreases as the salinity increase. However the dry matter of the shoot increases as a result of the vegetative growth decrease as the salinity level increase. It was found that in the treatment of clay soil, medium irrigation level, and regular fertilizers in the case of low salinity levels(1gm salt addition per 1 kg of soil)the shoot dry matter equal 15.2 were in the same treatment in the case of high salinity of 8gm salt addition it is found that the dry matter shoot equal 20.
- The dry weight of the root decrease as the salinity level increase. However the dry matter of the plant root, and the increase of the dry matter of the root was larger than the shoot dry matter.
- The Soil should not be allowed to dry completely because the osmotic potential retards water up take. So sufficient water (4L/week)

for plant should be applied with each irrigation to result in leaching of some salt in drainage water.

- The quality parameters improved with increasing the salinity but the yield decreases so all treatments must be used to increase the plant tolerance to salinity.

In Summary, the salinity tolerance of cherry tomatoes will enable their growth in saline areas. This could be of greater important to grower. Now that commercial production is increasing. The consumer will receive a high – quality product as its found that salinity increase fruit quality parameters.

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7.Appendices

7.1. Appendix (A)

7.2. Appendix (B)

7.3. Appendix (C)

7.4. Appendix (D)

7.5. Appendix (E)

7.1. Appendix (A)

Table A1:Monthly climatic averages at Tulkarem area

Element	Jan.	Feb	Mar	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Max. Temp.(C)	13.3	13.8	16.7	21.5	24.6	27.2	29	29.6	28.2	26.8	20.8	15.9
Mean Min. Temp.(C)	8.6	8.7	10.8	13.8	15.9	19.4	22.7	22.7	21.2	19.2	14.3	10.6
A bsolute Max. Temp. (C)	20	20.7	23	31	32	31	34	34	33.2	32.5	27.7	22.3
A bsolute Min. Temp. (C)	4.2	4.8	7.2	9.6	12.6	16.1	20.3	20.3	18.5	14.9	10.8	7.3
Mean Temp.(C)	10.9	11.2	13.7	17.6	20.2	23.3	26.1	26.1	24.7	23	17.5	13.2
Mean Wind Speed (Km/h)**	4.3	4.1	3.8	3.4	3.3	2.9	2.7	2.7	2.6	2.9	3.8	4
Mean RH %	72	76	75	65	62	69	74	74	70	67	64	71
Total Rainfall (mm)*	110.9	103.5	86.6	18.2	3.7	0.1	0	0	0	25.9	90.3	162.1
Total PET (mm)*	37	31	46	72	92	95	108	104	100	100	75	48
Max. Monthly Rainfall	330	390	181	113	34	6	2	0	19	92	367	436

Table A2 : Experiment sketch

soil Type 1 Irr. Water1 Fer. (N1,P1,K3) salt.Tre. 0gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P2,K1) salt.Tre. 0gm/kg	soil Type 3 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 1gm/kg	soil Type 3 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N1,P1,K3) salt.Tre. 1gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P2,K1) salt.Tre.1gm/kg	soil Type 3 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Type 3 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 3gm/kg	soil Type 2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre.1gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N1,P1,K3) salt.Tre. 3gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P2,K1) salt.Tre.3gm/kg	soil Type 2 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.3gm/kg	soil Type 3 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Type 3 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 6gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N1,P1,K3) salt.Tre. 6gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P2,K1) salt.Tre.6 gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.3gm/kg	soil Type 2 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Type 2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N1,P1,K3) salt.Tre. 8gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P2,K1) salt.Tre. 8gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.0gm/kg	soil Type 1 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 3gm/kg	soil Type 3 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N2,P1,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P3,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.1gm/kg	soil Type 2 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Type 2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 3gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N2,P1,K1) salt.Tre. 1gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P3,K1) salt.Tre. 1gm/kg	soil Type3 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 5gm/kg	soil Type 2 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 1gm/kg	soil Type 2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N2,P1,K1) salt.Tre. 3gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P3,K1) salt.Tre. 3gm/kg	soil Type2 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.8gm/kg	soil Type 3 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 1gm/kg	soil Type 3 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 3gm/kg	soil Ty.1; Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N2,P1,K1) salt.Tre. 6gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P3,K1) salt.Tre. 6gm/kg	soil Type1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.8gm/kg	soil Type 1 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Type 2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 5gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N2,P1,K1) salt.Tre. 8gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P3,K1) salt.Tre. 8gm/kg	soil Type 2 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 5gm/kg	soil Type 1 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 5gm/kg	soil Type 1 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 5gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N3,P1,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K2) salt.Tre.0gm/kg	soil Type2 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Type 3 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 1gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N3,P1,K1) salt.Tre. 1gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K2) salt.Tre. 1gm/kg	soil Type1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.5gm/kg	soil Type2 Irr. Water3 Fer. (N1,P1,K1) salt.Tre.3gm/kg	soil Type 1 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 3gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Fer. (N3,P1,K1) salt.Tre. 3gm/kg	soil Type 1 Irr. Water1 Fer. (N1,P1,K2) salt.Tre. 03m/kg	soil Type 2 Irr. Water1 Fer. (N1,P1,K1) salt.Tre1gm/kg	soil Type 3 Irr. Water3 Fer. (N1,P1,K1) salt.Tre.5gm/kg	soil Type 1 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 8gm/kg	soil Ty.1, Mulch Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg
soil Type 1 Irr. Water1 Irr. Water1 Fer. (N3,P1,K1) salt.Tre. 8gm/kg	soil Type 1 Irr. Water1 Irr. Water1 Fer. (N1,P1,K2) salt.Tre. 8gm/kg	soil Type3 Irr. Water1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre.1gm/kg	soil Type 2 Irr. Water3 Irr. Water3 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Type 1 Irr. Water2 Irr. Water2 Fer. (N1,P1,K1) salt.Tre. 0gm/kg	soil Ty.1, Mulch Irr. Water1 Irr. Water1 Fer. (N1,P1,K1) salt.Tre. 0gm/kg

Table A3 : Results of Soil and water analysis at the begning of planting season

Soil Type	Sample#	Salt Conc. g/Kg	EC ds/m	PH	K (PPm)	Ca+2 + Mg+2 Meq /1	Na (ppm)	No3(ppm)	P(ppm)	Cl(ppm)	SAR
Clay	1	0	1.67	7.8	58	11.5	67	208	28.88	92	0.859
Clay	2	1	4.2	7.7	56	14.3	200	233	28	374	2.299
Clay	3	3	10.36	7.5	48	20.3	320	240	28.5	550	3.087
Clay	4	6	15	7.6	42	42	450	250	27.5	920	3.08
Clay	5	8	19.87	7.8	40	72	620	265	28	1120	3.176
Mixture	6	0	1.88	7.1	48	9.5	54	154	25	75	0.76
Mixture	7	1	5	6.8	47	18	287	166	24.5	384.7	2.94
Mixture	8	3	11	6.8	48	40	485	160	24	944	3.334
Mixture	9	6	16	6.4	44	55	654	155	25	1054	3.849
Mixture	10	8	22	7.1	42	68	756	172	25	1436	3.986
Sand	11	0	2.47	7	57	10	67	44	14.4	103	0.921
Sand	12	0	5.4	6.8	56	13.5	200	35	14.7	380	2.366
Sand	13	0	11.89	6.6	55	48	576	40	14	1046	3.614
Sand	14	0	18	6.8	55	65	720	38	14	1302	3.88
Sand	15	0	22	6.7	54	75	840	42	14	1546	4.217
Water	16	0	1.09	8	8	13	84			141	1.0129

Table A4 :Results of soil analysis at the end of the planting season

Sample No.	Notes	salt Conc. g/Kg	EC ds /m	PH	K (ppm)	P (ppm)	No3 (ppm)	CL (ppm)	Na (ppm)	Ca + Mg meq / L	SAR
1a	irr. 1, soil type1, N1-P1-K1	3gm	8.3	7.6	43	52	56	300	143	4.5	2.93
1b	irr. 1, soil type1, N1-P1-K1	3gm	6	6.95	22	33	38	225	120.8	4	2.63
1c	irr. 1, soil type1, N1-P1-K1	3gm	24.2	7.65	83	98	102	1300	680	13.8	7.95
2a	irr. 1, soil type2, N1-P1-K1	3gm	10.2	7.9	57	49	77	340	166	5.2	3.16
2b	irr. 1, soil type2, N1-P1-K1	3gm	7.8	6.5	25	44	53	280	152	4.2	3.2
2c	irr. 1, soil type2, N1-P1-K1	3gm	28.5	8.1	68	85	99	1430	806.7	15.6	8.8
3a	irr. 1, soil type3, N1-P1-K1	3gm	11.5	7.5	48	40	68	350	187	4.5	3.8
3b	irr. 1, soil type3, N1-P1-K1	3gm	8.3	8	16	31	44	230	124	3	3.11
3c	irr. 1, soil type3, N1-P1-K1	3gm	29	7.2	93	102	85	1622	895	17.8	9.2
4a	irr. 2, soil type1, N1-P1-K1	3gm	11.2	7.9	38	51	45	400	244	6	4.33
4b	irr. 2, soil type1, N1-P1-K1	3gm	8.7	8.1	28	46	44	304	167	4.6	3.38
4c	irr. 2, soil type1, N1-P1-K1	3gm	23	6.5	75	95	88	1214	850	13.4	10.09
5a	irr. 2, soil type2, N1-P1-K1	3gm	10.5	7.8	36	72	62	360	154	5.2	2.936
5b	irr. 2, soil type2, N1-P1-K1	3gm	7.5	7.6	25	58	53	280	132	3.9	5.73
5c	irr. 2, soil type2, N1-P1-K1	3gm	27	8	83	112.2	92	1230	720.5	14.5	8.22
6a	irr. 2, soil type3, N1-P1-K1	3gm	12	8.12	34	48	55	450	258	5.7	4.69
6b	irr. 2, soil type3, N1-P1-K1	3gm	8.3	7.7	21	45	56	311.5	148	4.3	3.103
6c	irr. 2, soil type3, N1-P1-K1	3gm	26.5	7.9	72	105	80	1350	766	14.4	8.77
7a	irr. 3, soil type1, N1-P1-K1	3gm	7.1	7.82	25	50	49	287	134	2.8	3.48
7b	irr. 3, soil type1, N1-P1-K1	3gm	5	7.7	13	50	40	205	112	3.2	2.722
7c	irr. 3, soil type1, N1-P1-K1	3gm	21	7.25	75	92	97	1175	670	12.8	8.142
8a	irr. 3, soil type2, N1-P1-K1	3gm	7.3	7.65	48	42	44	280	123	3.4	2.9
8b	irr. 3, soil type2, N1-P1-K1	3gm	5.8	7.4	23	34	32	223	107	3.2	2.6
8c	irr. 3, soil type2, N1-P1-K1	3gm	22	7.7	72	84	108	1205	509	11.9	6.4
9a	irr. 3, soil type3, N1-P1-K1	3gm	8.9	7.3	36	38	38	300	145	4.1	3.11
9b	irr. 3, soil type3, N1-P1-K1	3gm	6.2	7.6	16	29	22	244	120	3	3.012
9c	irr. 3, soil type3, N1-P1-K1	3gm	24	8.1	86	88	92	1280	570	14.1	6.599
10a	irr. 1, soil type1, N2-P1-K1	3gm	7.5	6.8	39	58	78	266	123	3.4	2.89
10b	irr. 1, soil type1, N2-P1-K1	3gm	6	7.2	22	35	67	240.7	122	3.5	2.835
10c	irr. 1, soil type1, N2-P1-K1	3gm	24	7.3	84	100	140	1235	800	14.3	9.198
11a	irr. 1, soil type1, N3-P1-K1	3gm	8.4	7.65	63	55	180	302.5	145	3.3	3.46
11b	irr. 1, soil type1, N3-P1-K1	3gm	6.5	7.7	28	42	120	245	112	2.7	2.92
11c	irr. 1, soil type1, N3-P1-K1	3gm	27	8.15	80	93	300	1420	950	15.2	10.59
12a	irr. 1, soil type1, N1-P2-K1	3gm	8.5	8.1	40	31	78	320	165	3.7	3.7
12b	irr. 1, soil type1, N1-P2-K1	3gm	6.2	7.8	12	18	44	267	132	2.8	5.73
12c	irr. 1, soil type1, N1-P2-K1	3gm	22	7.3	22	68	95	1320	650	17.2	6.8
13a	irr. 1, soil type1, N1-P3-K1	3gm	10.3	7.85	63	69	83	450	207	6.5	3.5
13b	irr. 1, soil type1, N1-P3-K1	3gm	8	7.5	35	52	49	322	153	3.4	3.6
13c	irr. 1, soil type1, N1-P3-K1	3gm	28	6.9	85	135	100	1560	750	17.4	7.8
14a	irr. 1, soil type1, N1-P1-K2	3gm	8.9	7.2	28	52	75	407	230.9	5.3	4.36
14b	irr. 1, soil type1, N1-P1-K2	3gm	6.4	7.6	14	30	48	298	146	3.4	3.4
14c	irr. 1, soil type1, N1-P1-K2	3gm	25	7.25	58	89	98	1225	804	16.4	8.63
15a	irr. 1, soil type1, N1-P1-K3	3gm	9.2	7.75	53	63	89	380.6	223	4.8	4.425
15b	irr. 1, soil type1, N1-P1-K3	3gm	6.3	7.5	35	48	55	247	113	4	2.456
15c	irr. 1, soil type1, N1-P1-K3	3gm	26	8.1	120	92	102	1370	740	15.6	8.145
16a	irr. 1, soil type1, N1-P1-K3 with mulch cover	3gm	8.3	7.8	33	56	63	320	155	4.25	3.268
16b	irr. 1, soil type1, N1-P1-K3 with mulch cover	3gm	6.4	7.5	42	38	50	277	123	3	3.08
16c	irr. 1, soil type1, N1-P1-K3 with mulch cover	3gm	24	7.56	85	90	103	1430	820	14.8	9.267

7.2. Appendix (B)

Salt Tolerance Parameters

Relating Relative Yield to Increase

Salinity in the Root Zone

Fig B$_1$: Soil type .1, Irr. Level 1, (N1-P1-K1)

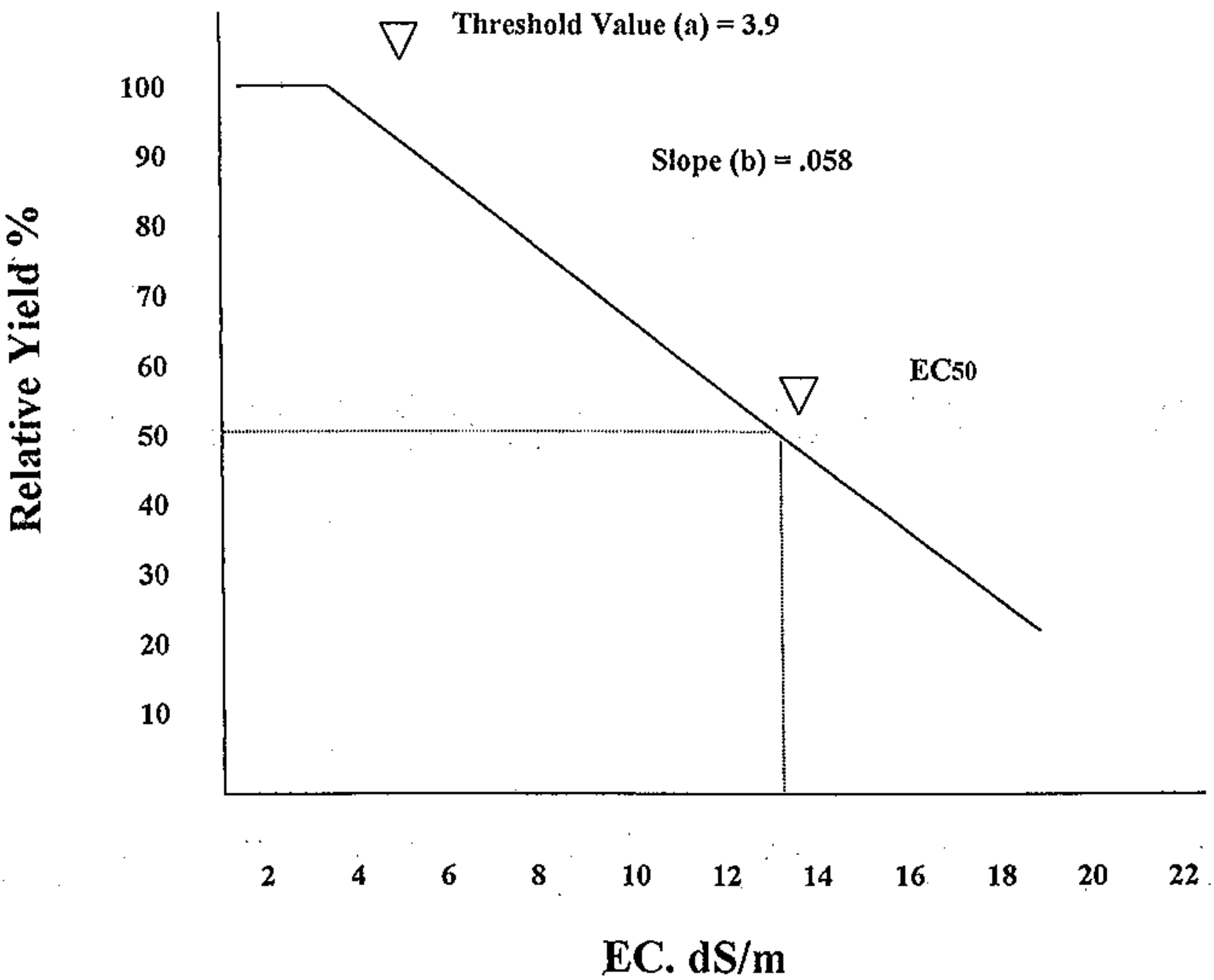


Fig B₂: Soil type .1, Irr. Level 2, (N1-P1-K1)

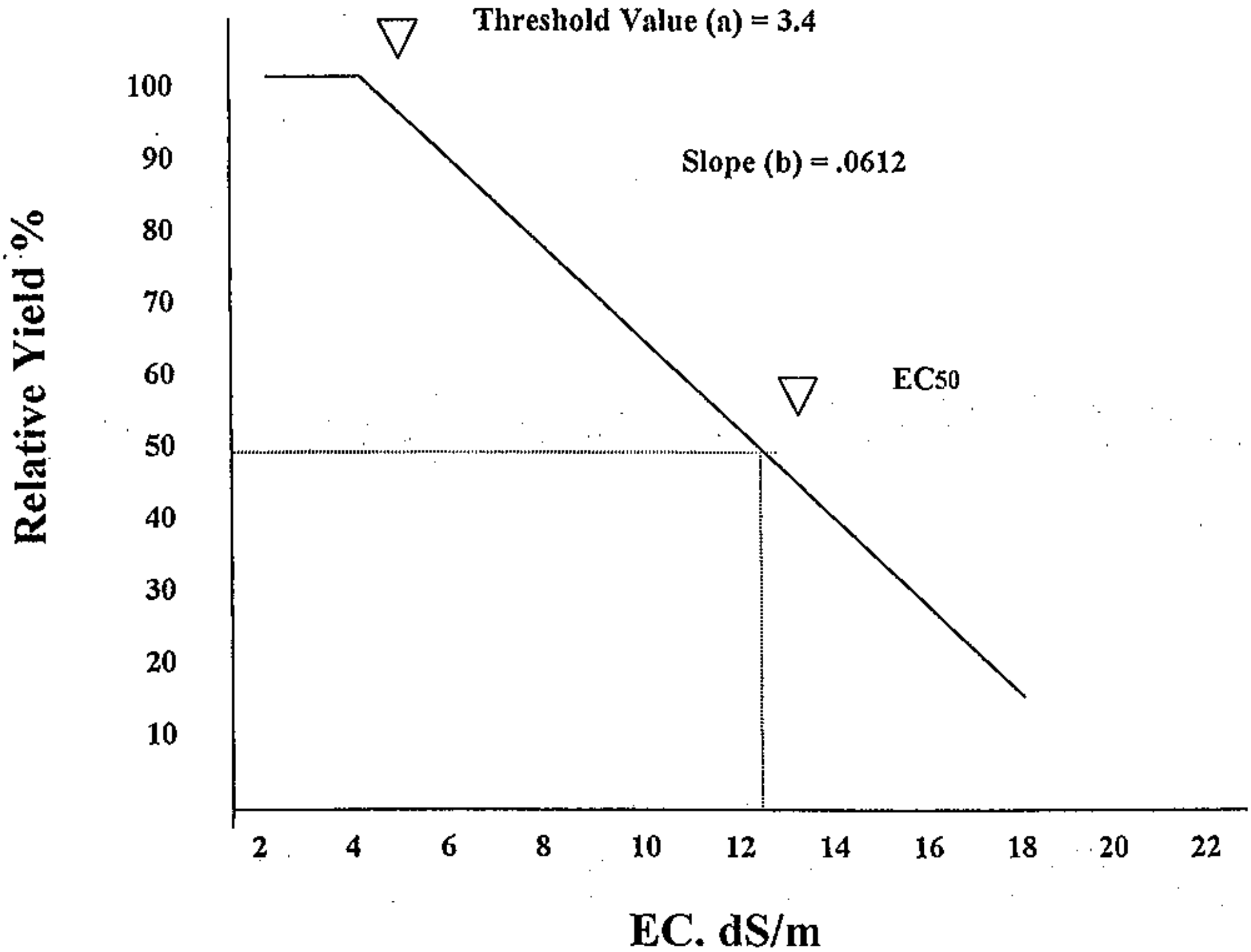


Fig B3: Soil type .1, Irr. Level 3, (N1-P1-K1)

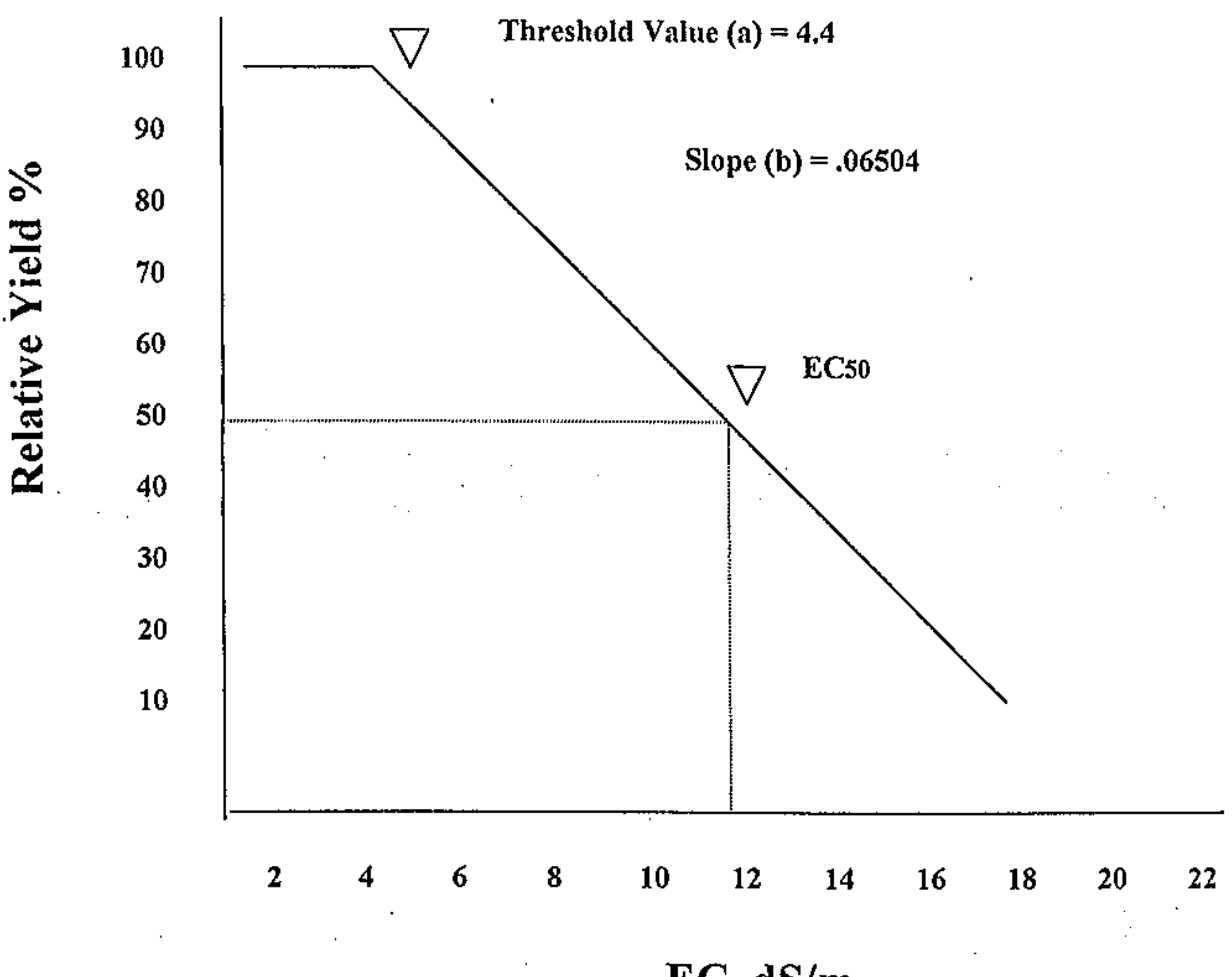


Fig B_4 : Soil type 2, Irr. Level 1, (N1-P1-K1)

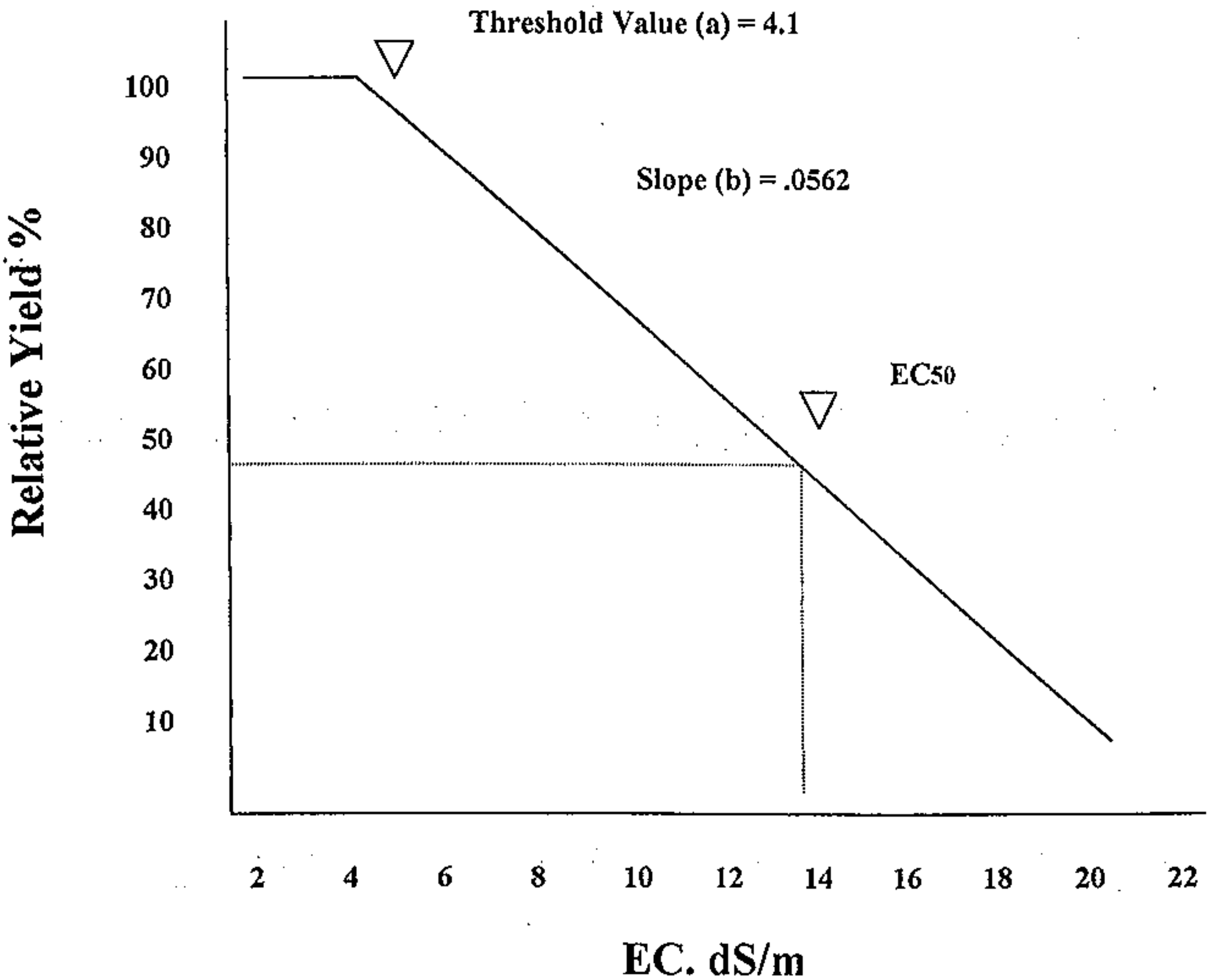


Fig B$_5$: Soil type 2, Irr. Level 2, (N1-P1-K1)

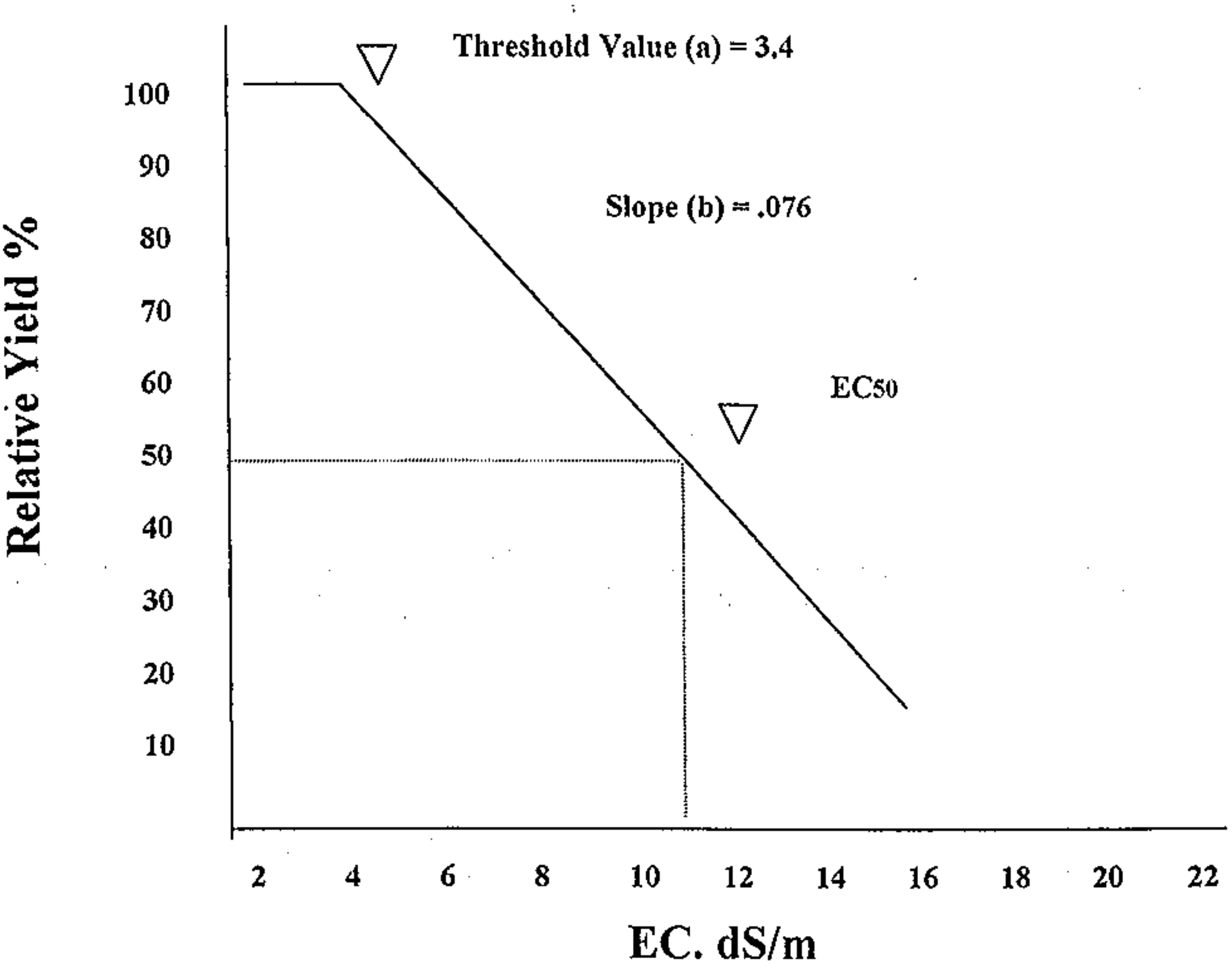


Fig B$_6$: Soil type .2, Irr. Level 3, (N1-P1-K1)

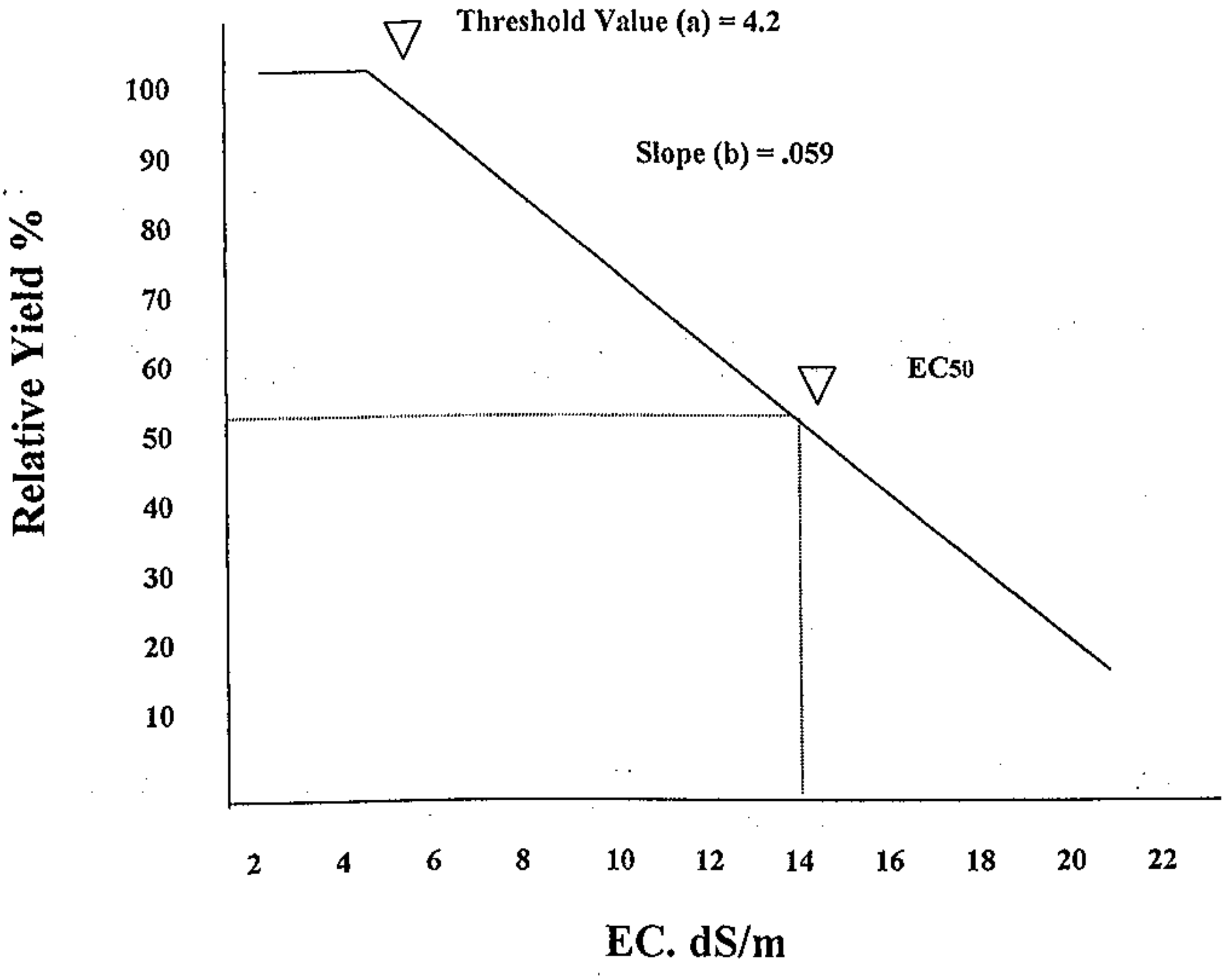


Fig B$_7$: Soil type 3, Irr. Level 1, (N1-P1-K1)

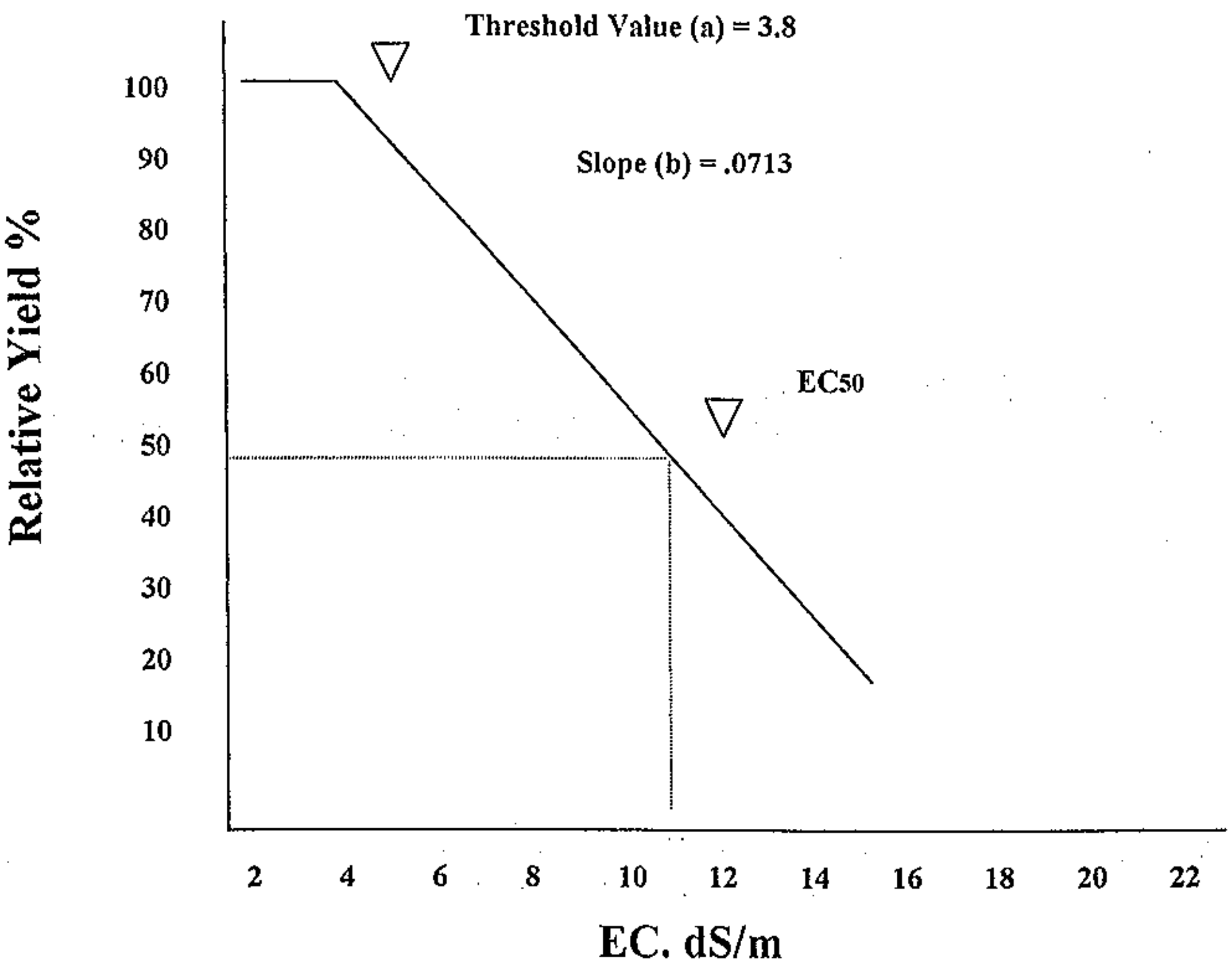


Fig B8: **Soil type 3, Irr. Level 2, (N1-P1-K1)**

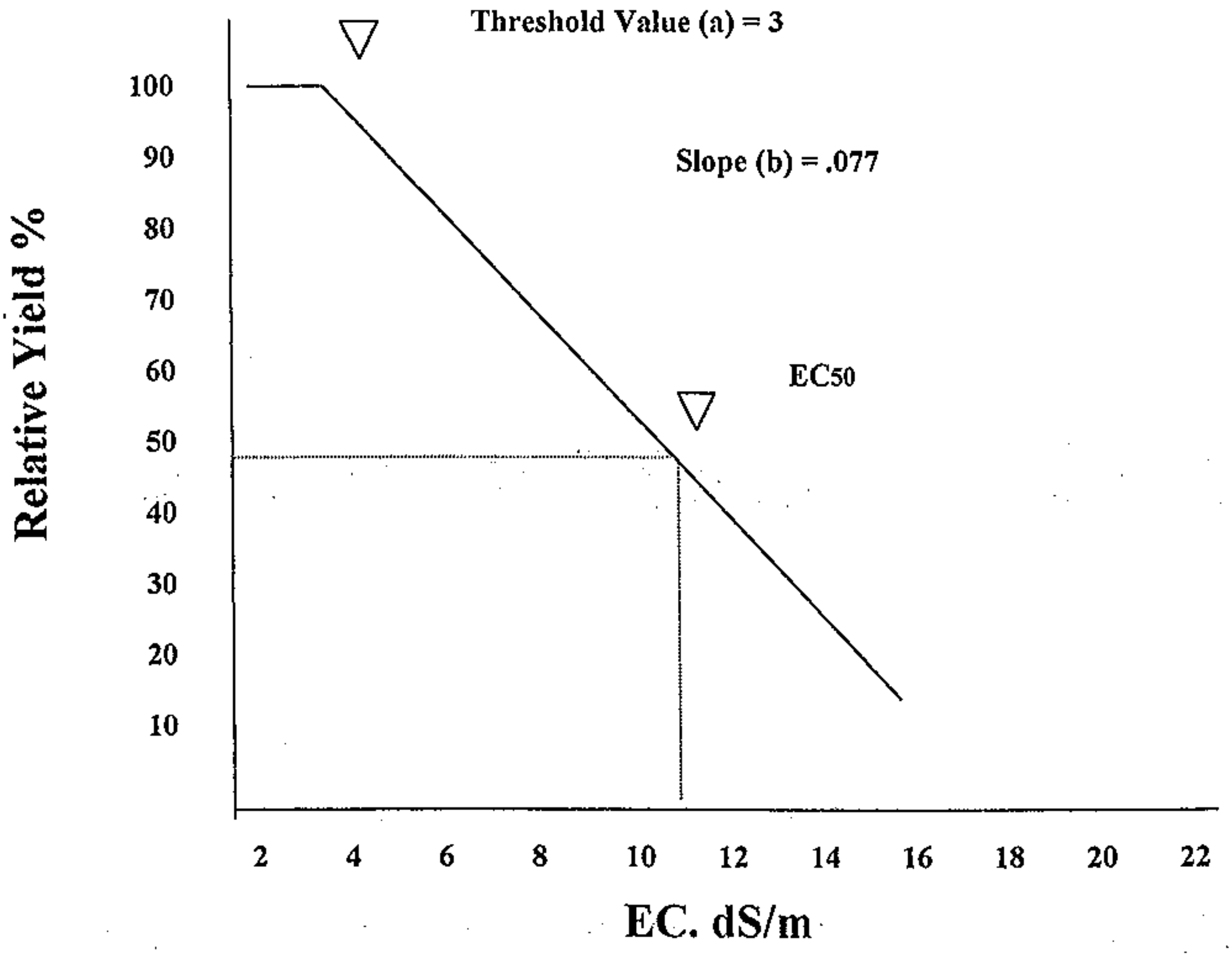


Fig B9: Soil type 3, Irr. Level 3, (N1-P1-K1)

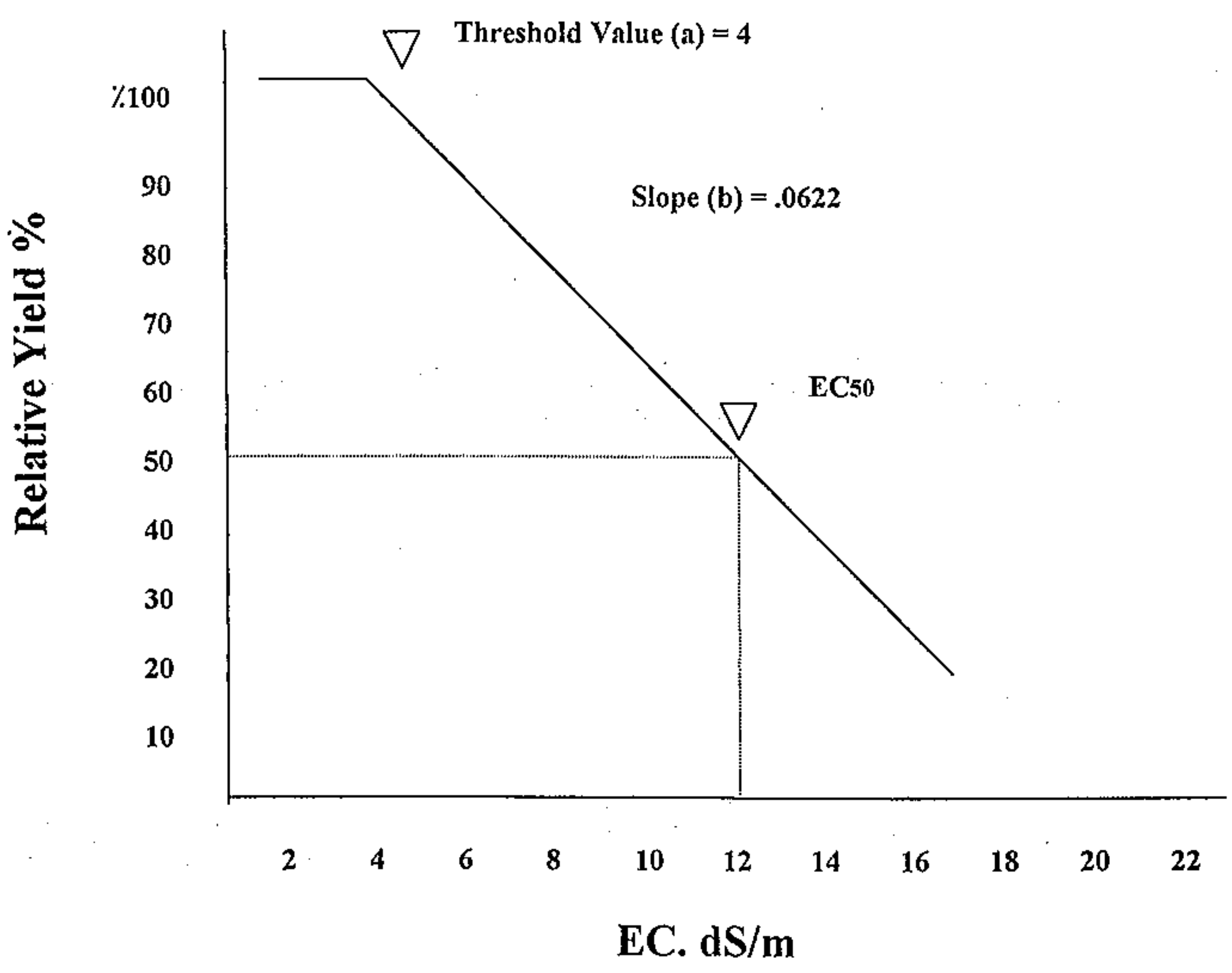


Fig B_{10} : Soil type .1, Irr. Level 1, (N2-P1-K1)

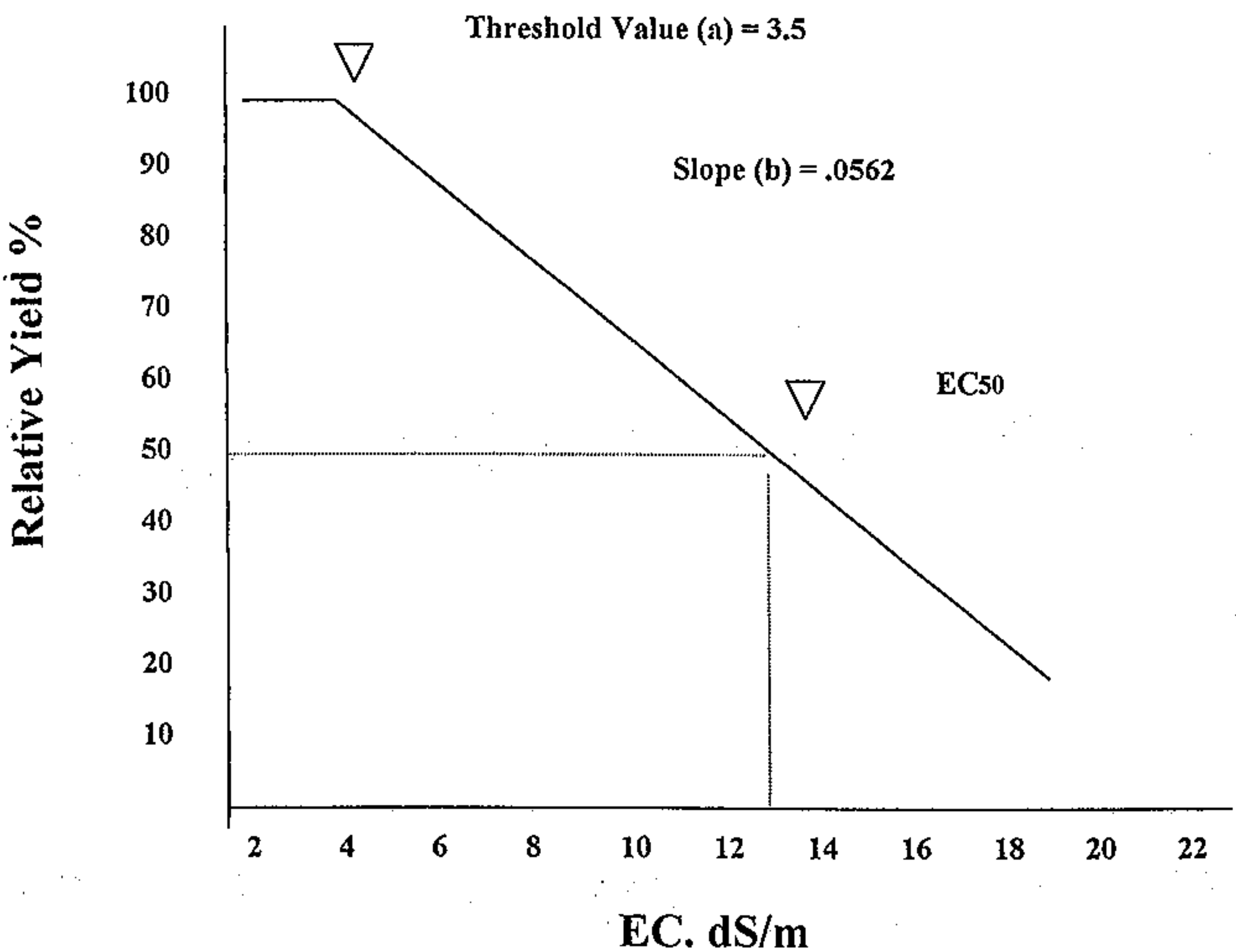


Fig B$_{11}$: Soil type .1, Irr. Level 1, (N3-P1-K1)

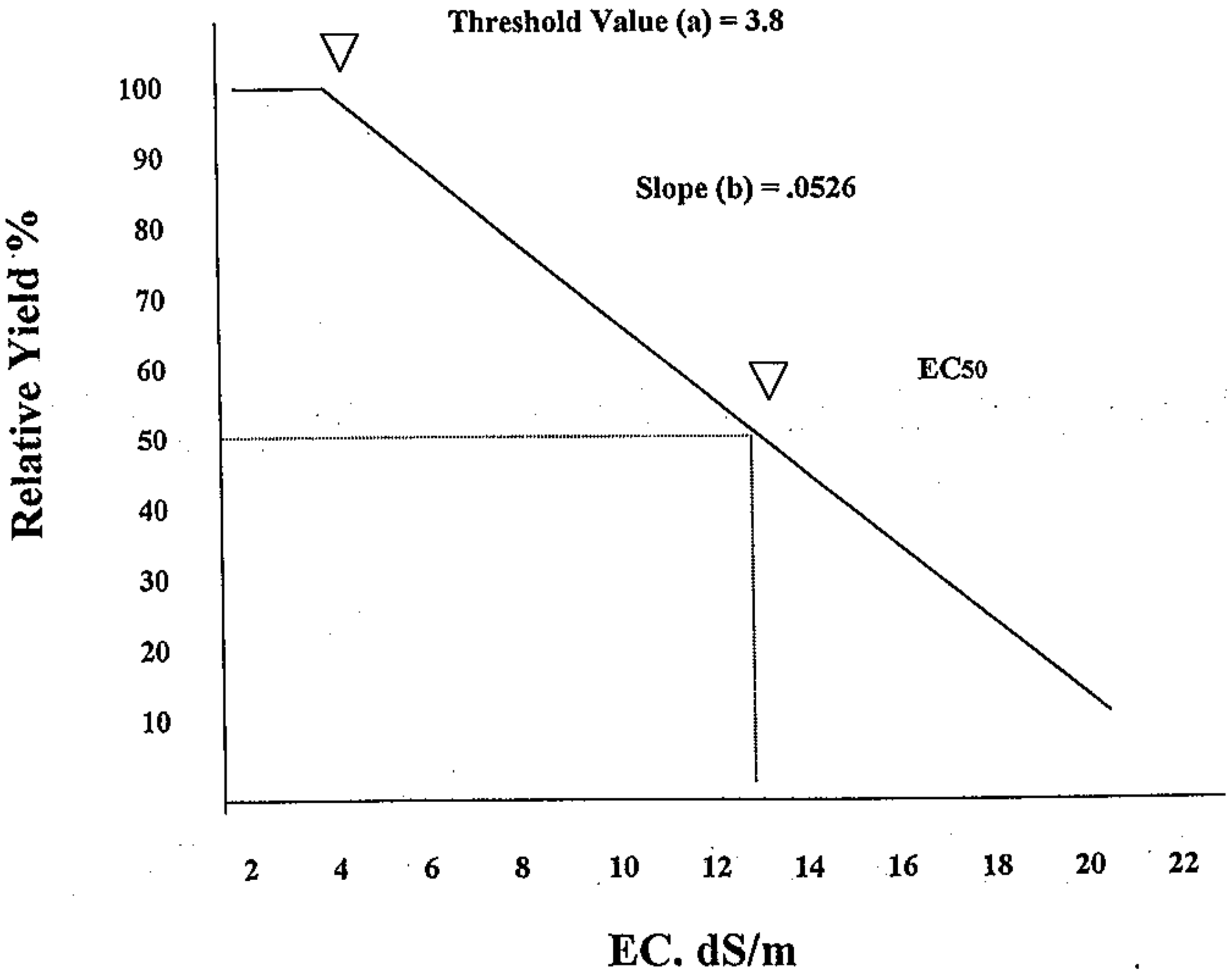


Fig B$_{12}$: Soil type .1, Irr. Level 1, (N1-P2-K1)

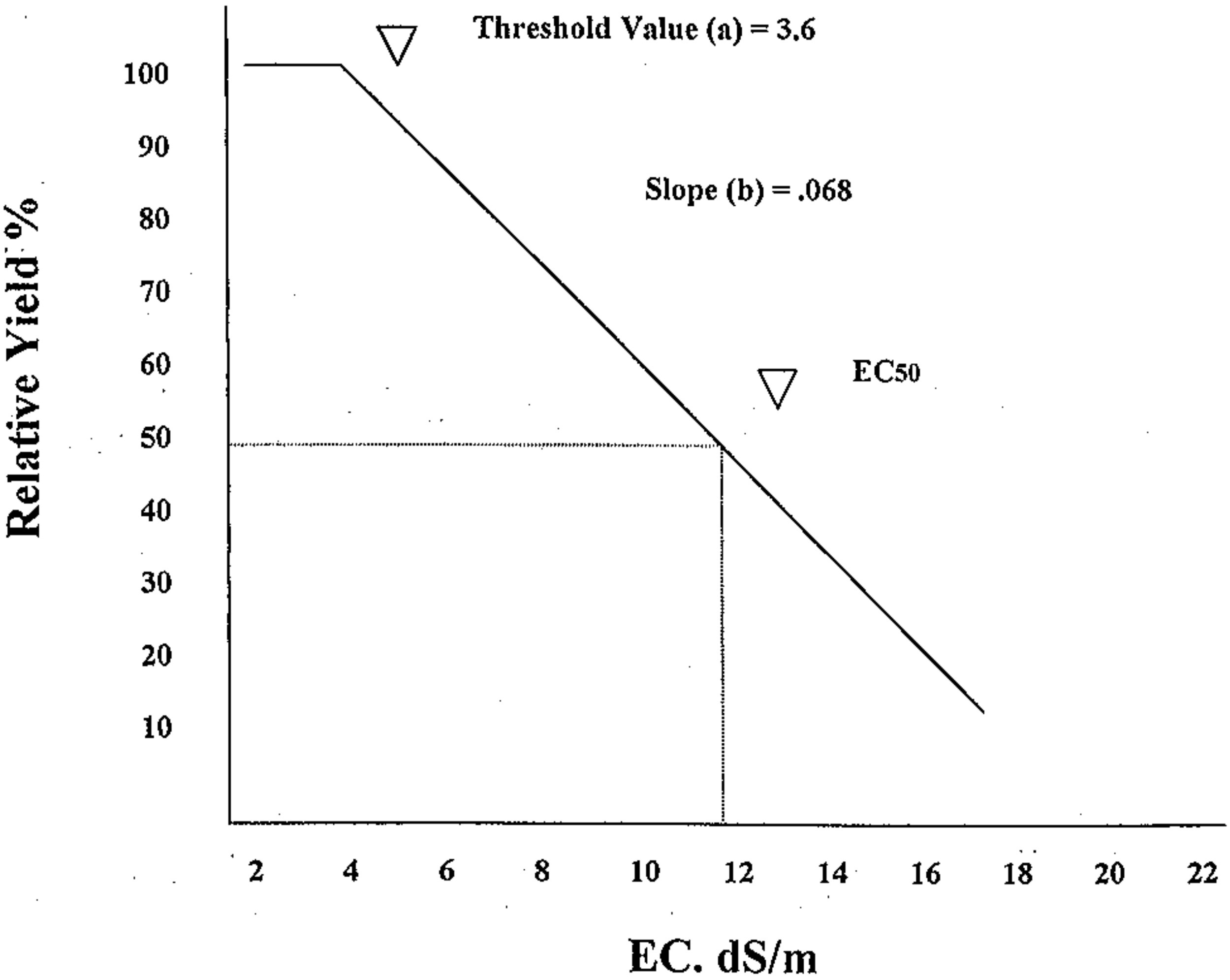


Fig B_{13}: Soil type .1, Irr. Level 1, (N1-P3-K1)

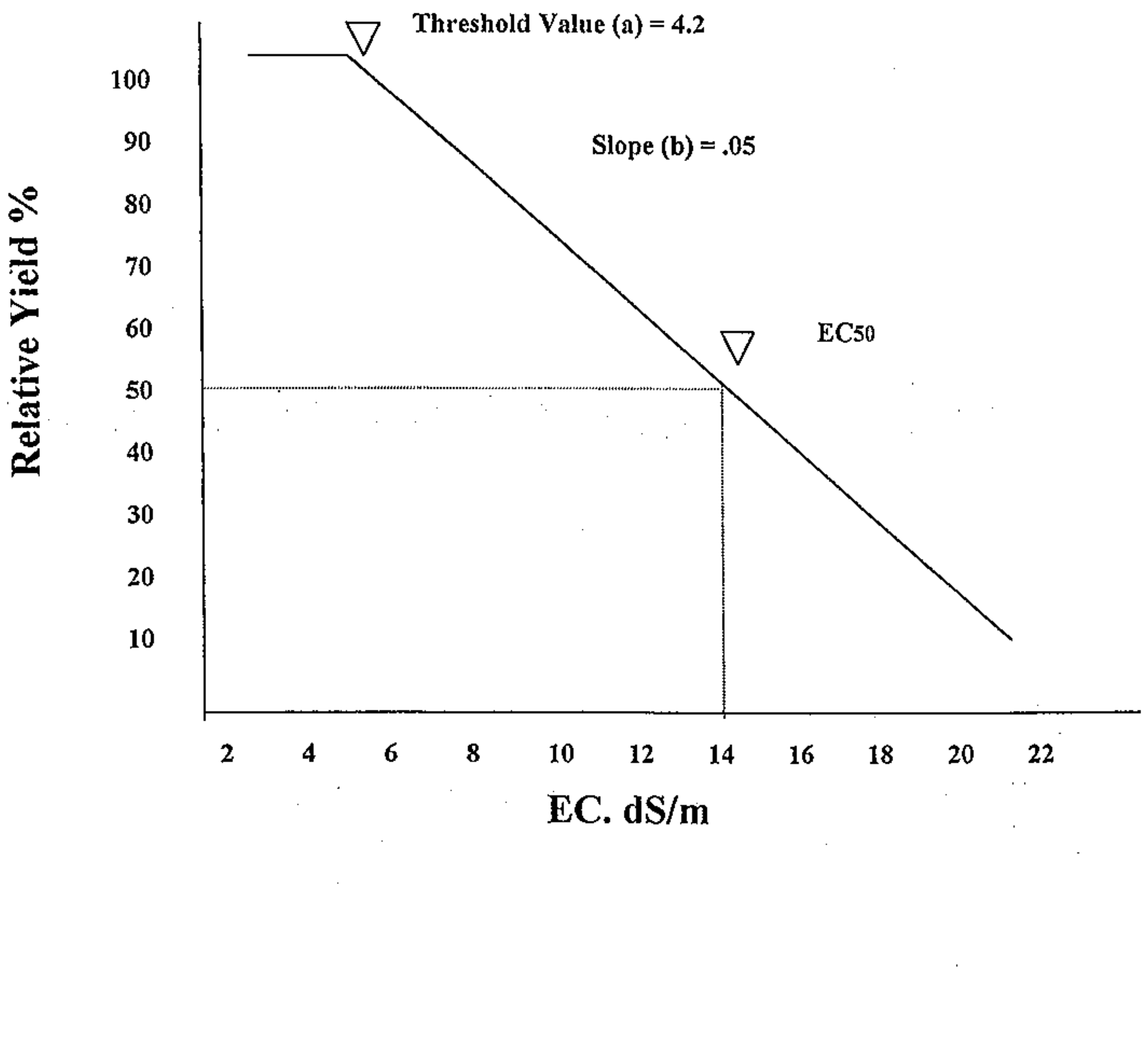


Fig B$_{14}$: Soil type .1, Irr. Level 1, (N1-P1-K2)

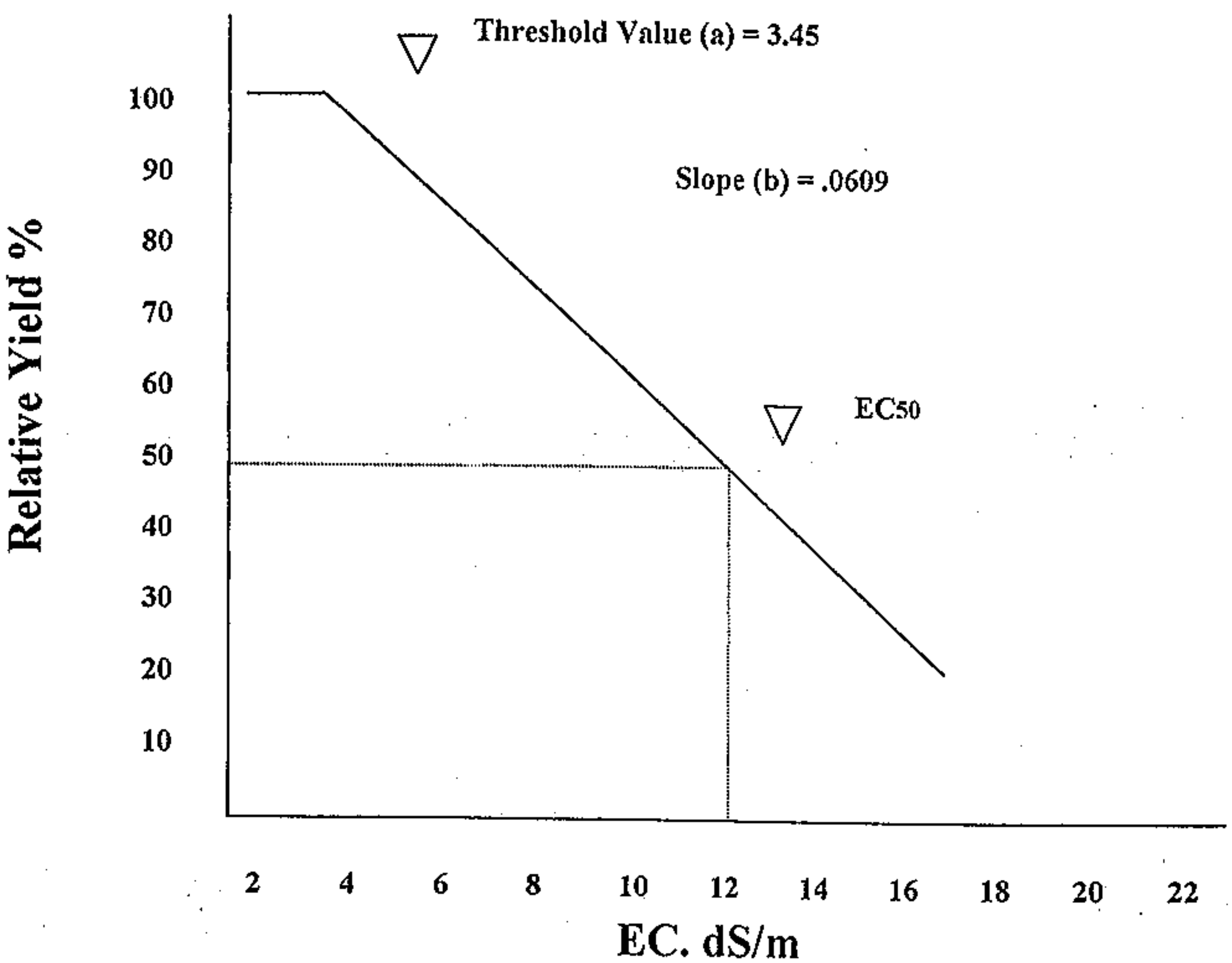


Fig B15 : **Soil type .1, Irr. Level 1, (N1-P1-K3)**

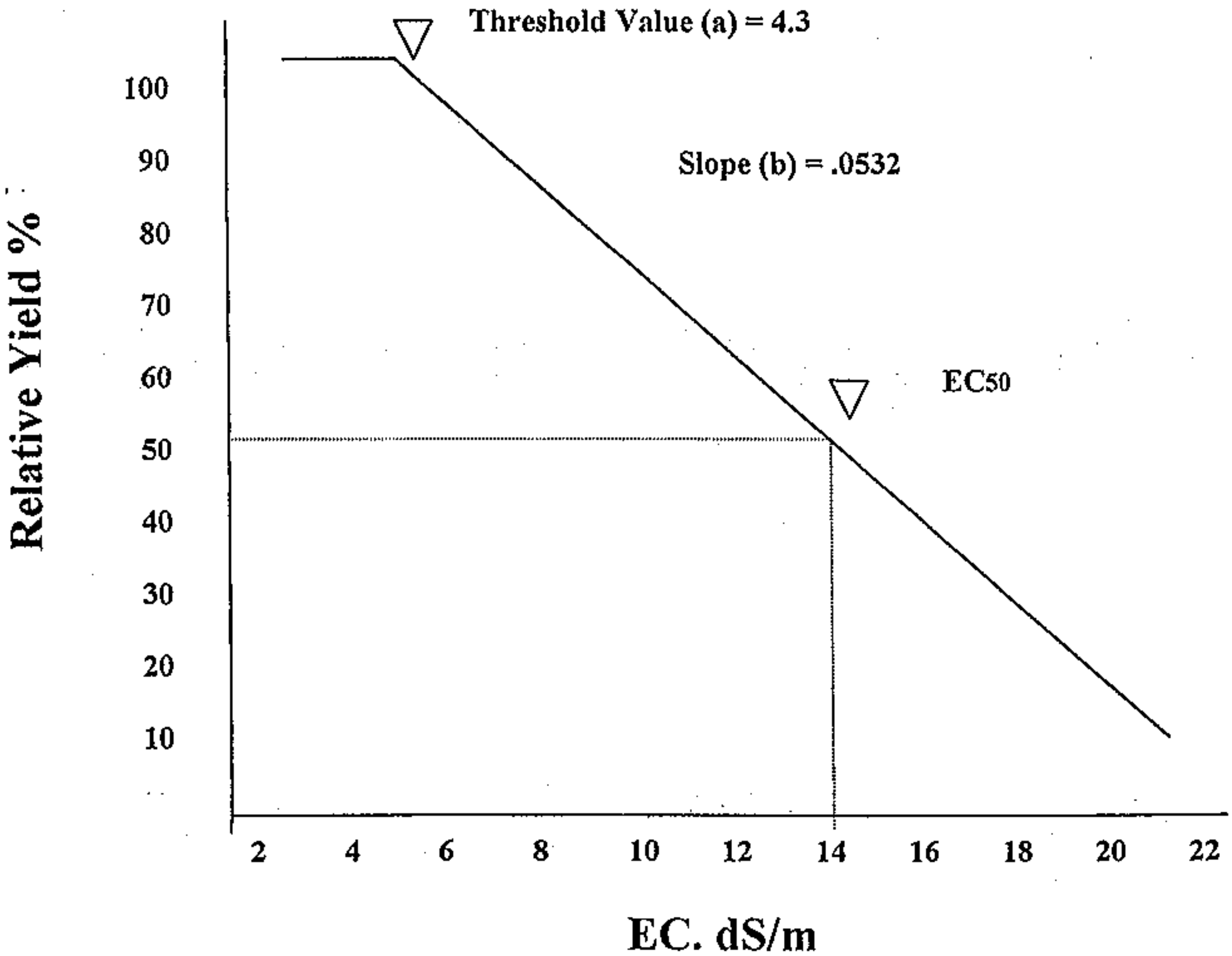
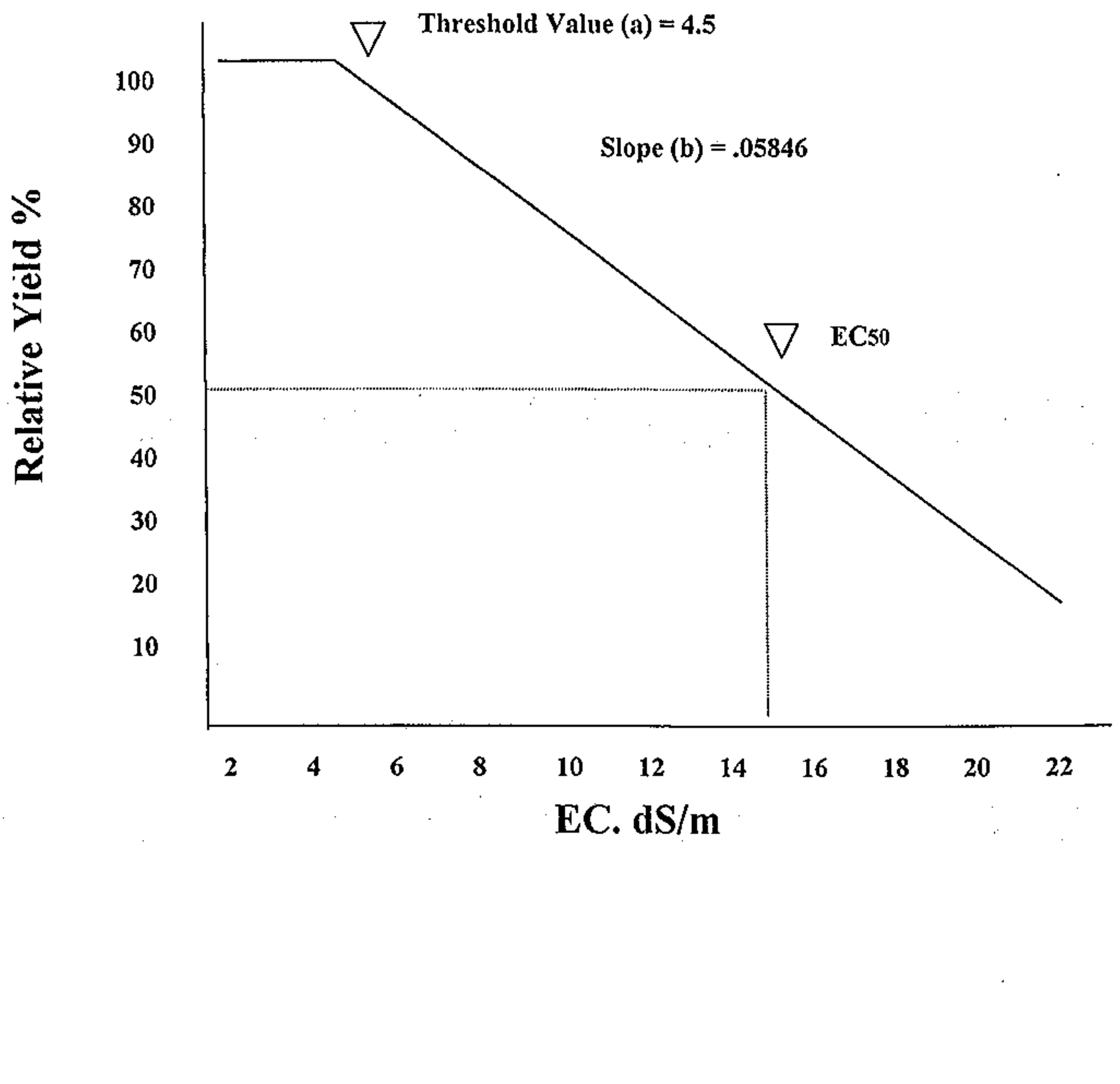


Fig B_{16}: **Soil type .1, Irr. Level 1, (N1-P1-K1)**
Mulch cover



7.3. Appendix (C)

Plant Length Versus Time

Figure C1 : Soil1. Water1. N1 P1 K1

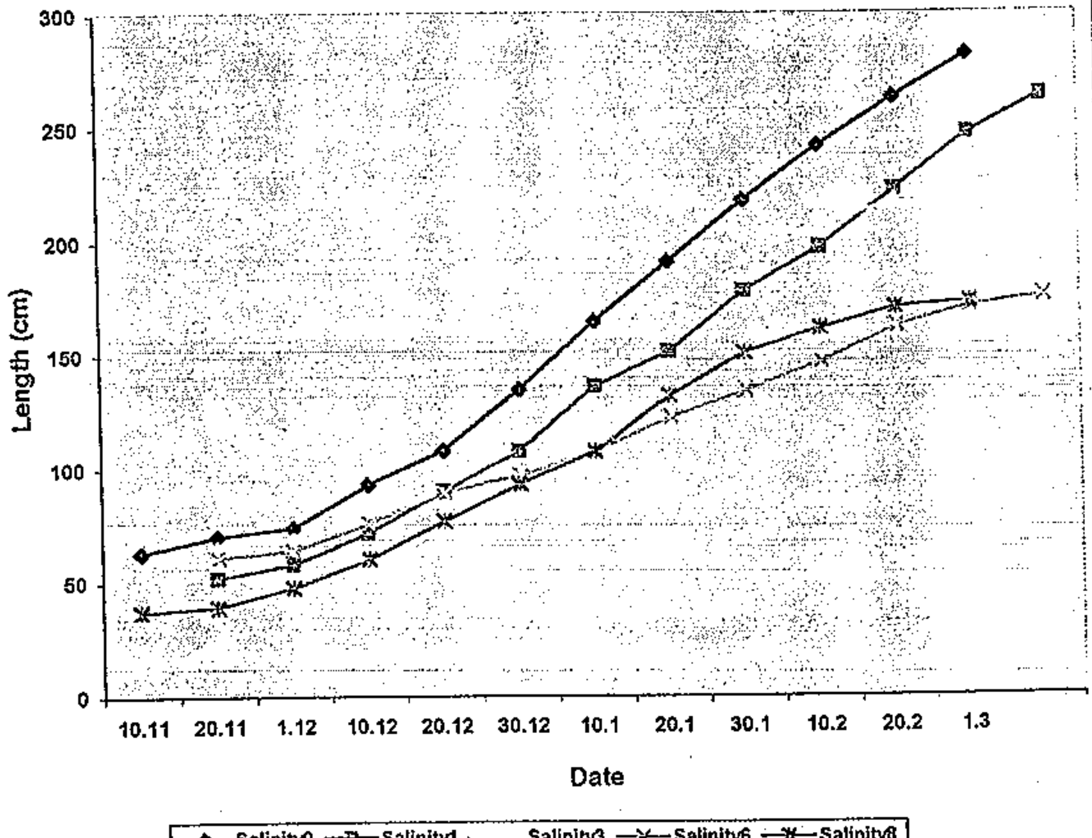
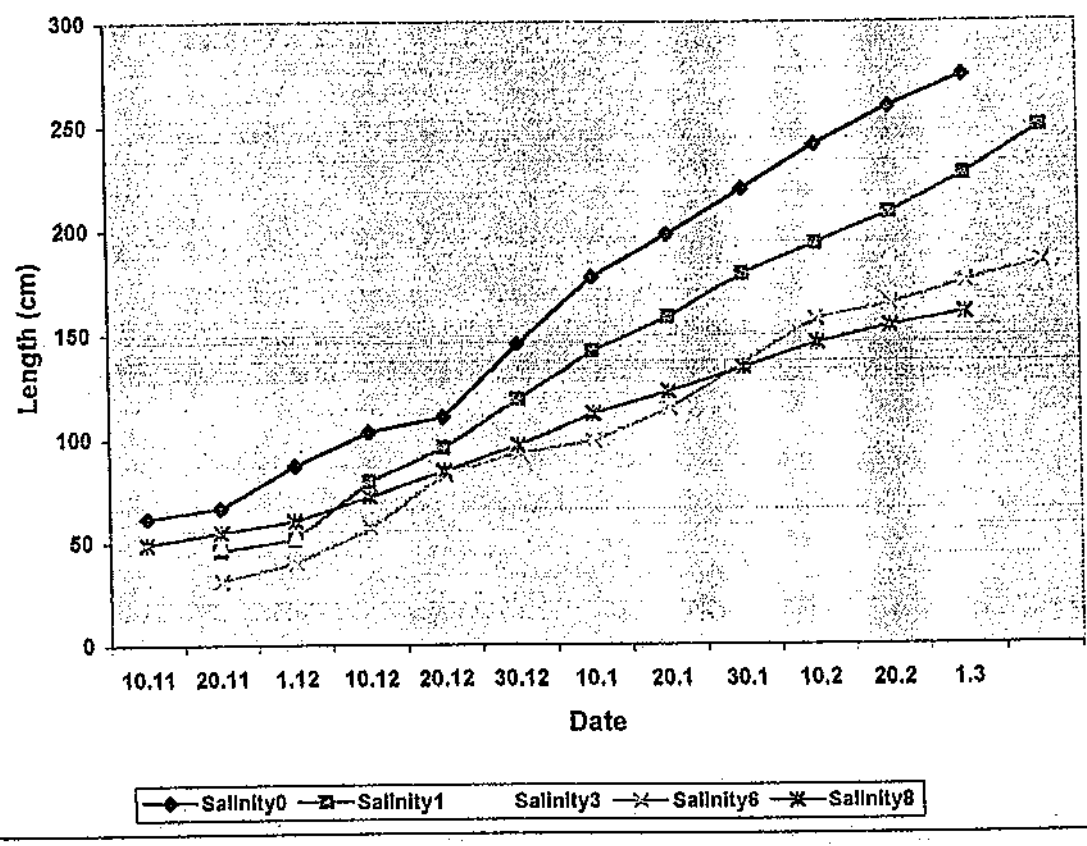


Figure C2 : Soil1. Water2. N1 P1 K1



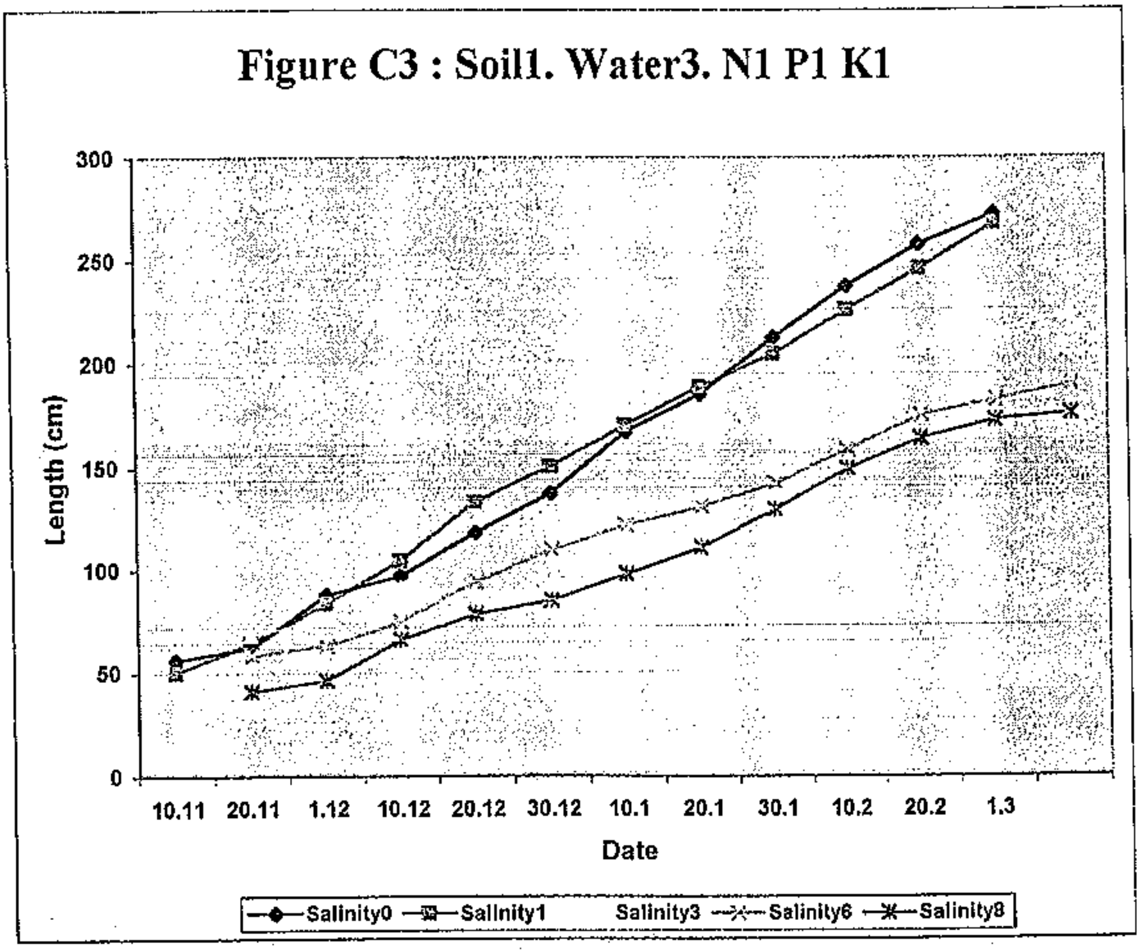


Figure C3 : Soil1. Water3. N1 P1 K1
Length (cm)
300
250
200
150
100
50
0
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

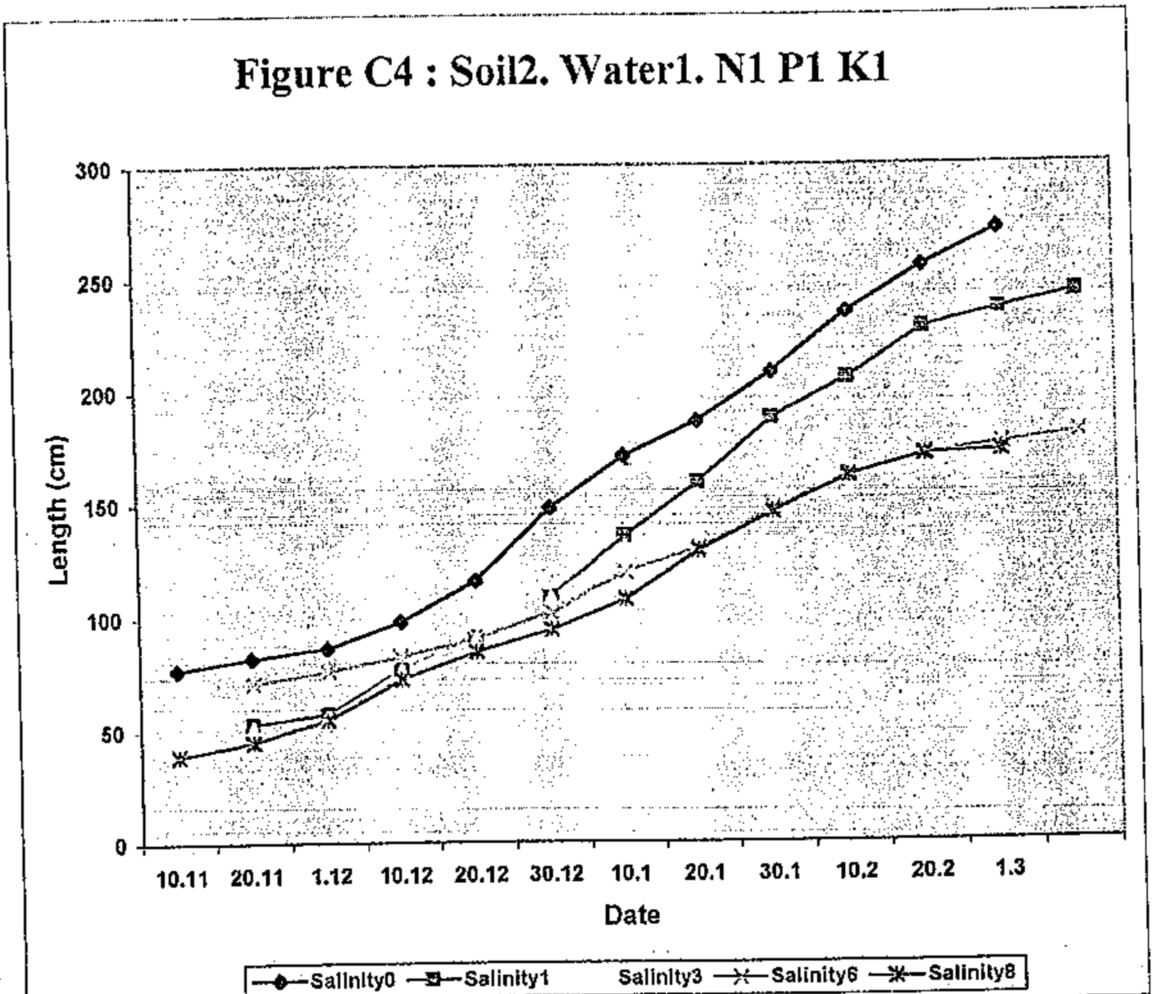


Figure C4 : Soil2. Water1. N1 P1 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

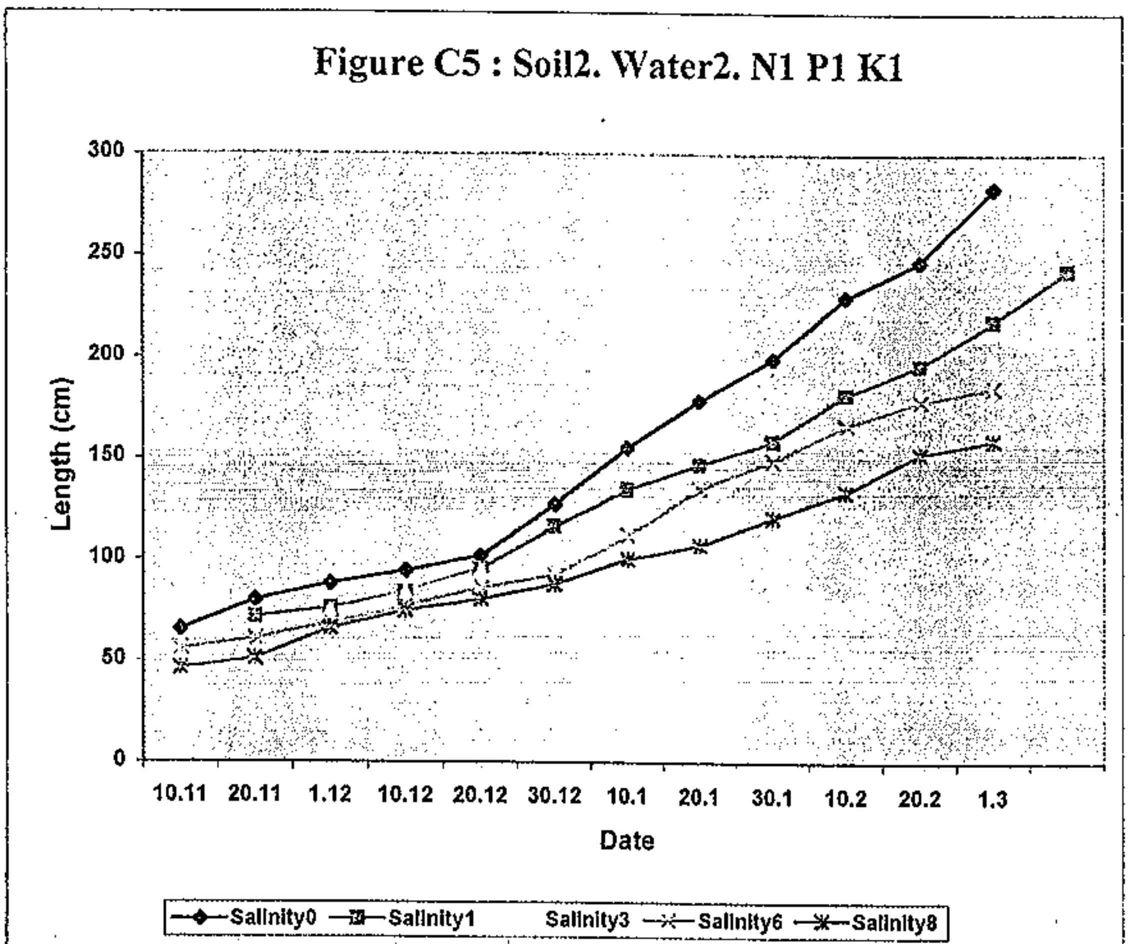


Figure C5 : Soil2. Water2. N1 P1 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

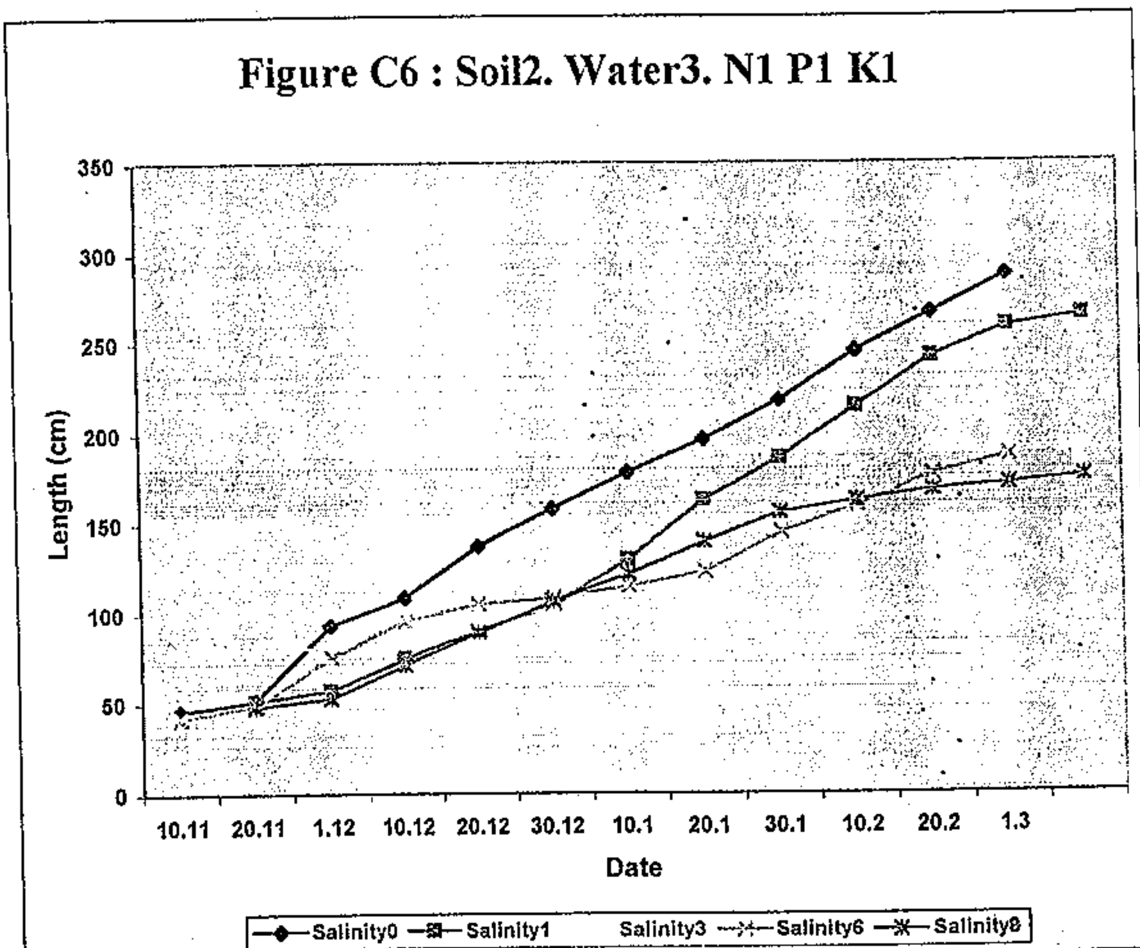


Figure C6 : Soil2. Water3. N1 P1 K1
350
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

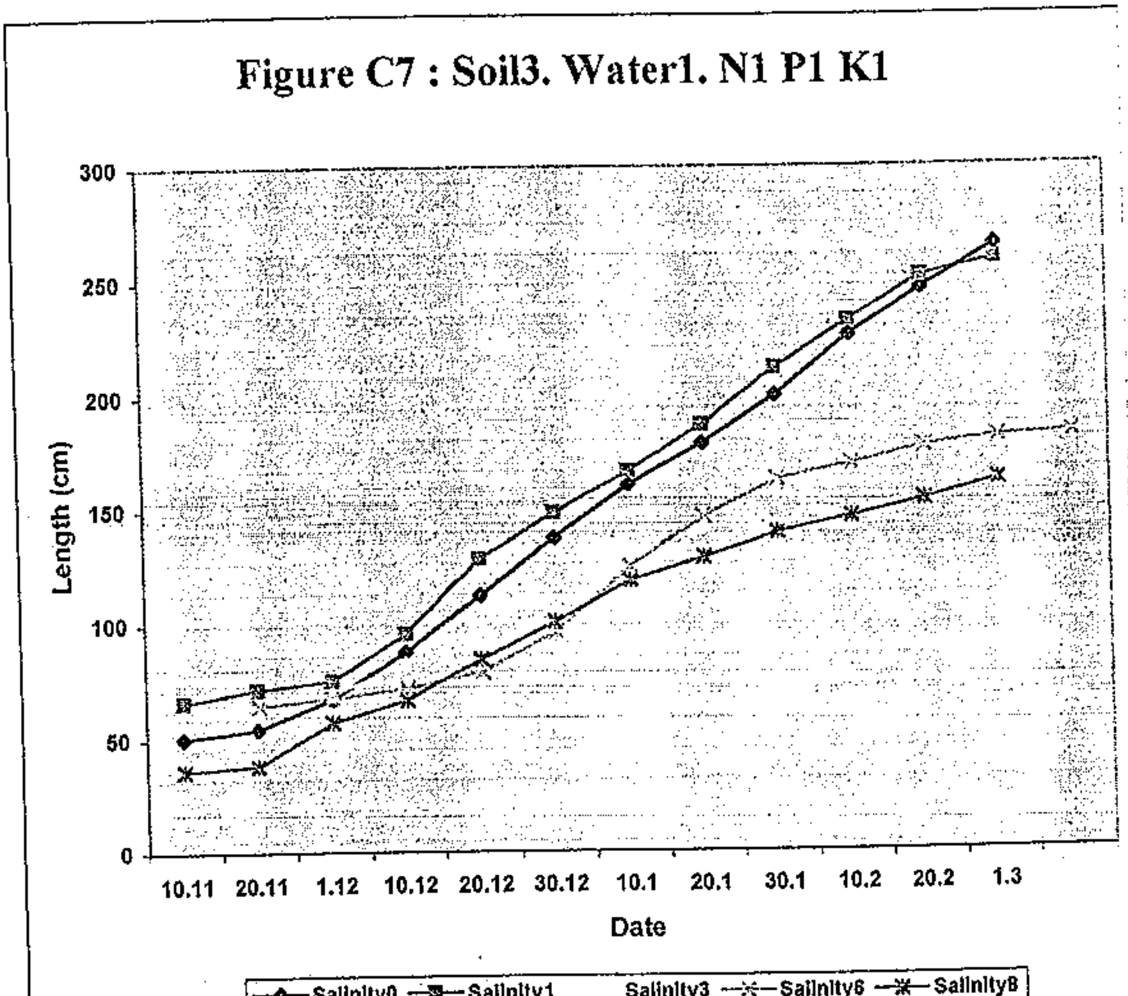


Figure C7 : Soil3. Water1. N1 P1 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

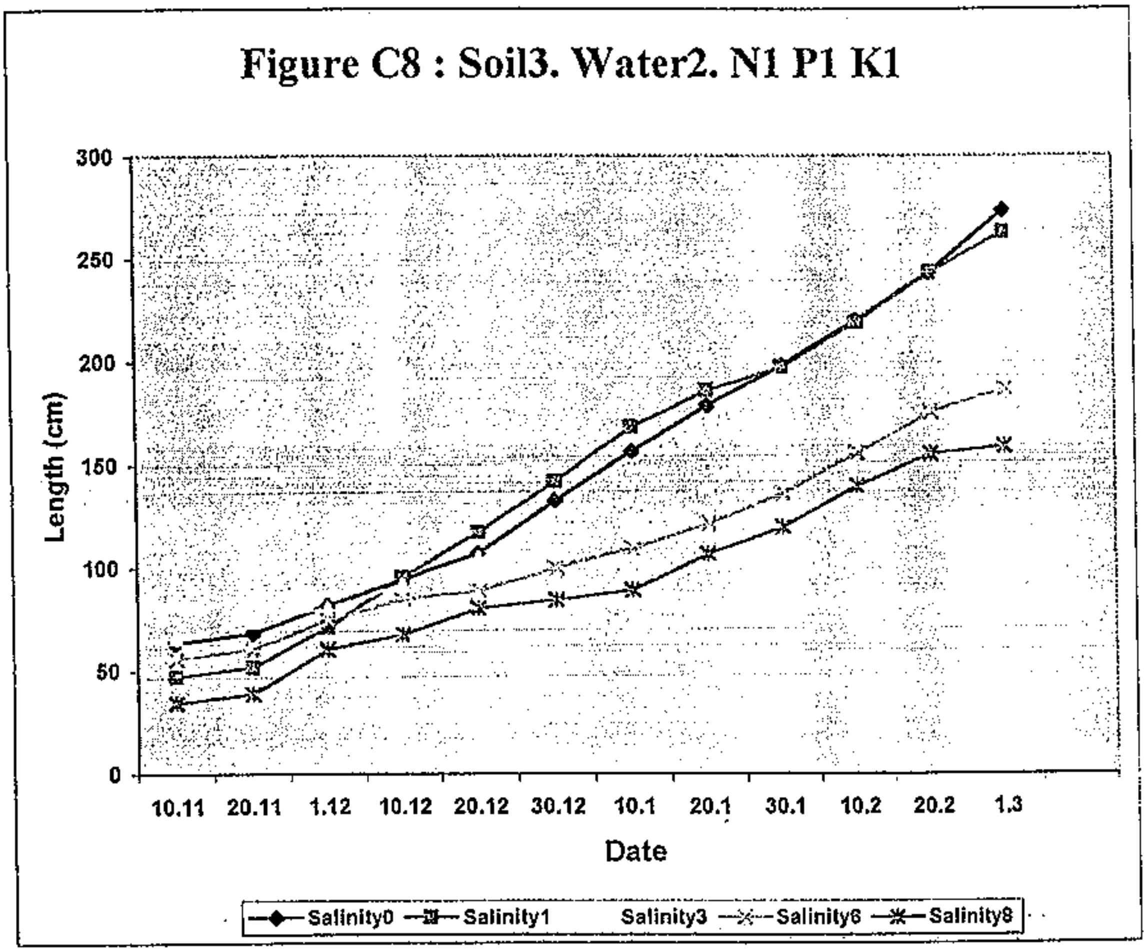


Figure C8 : Soil3. Water2. N1 P1 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

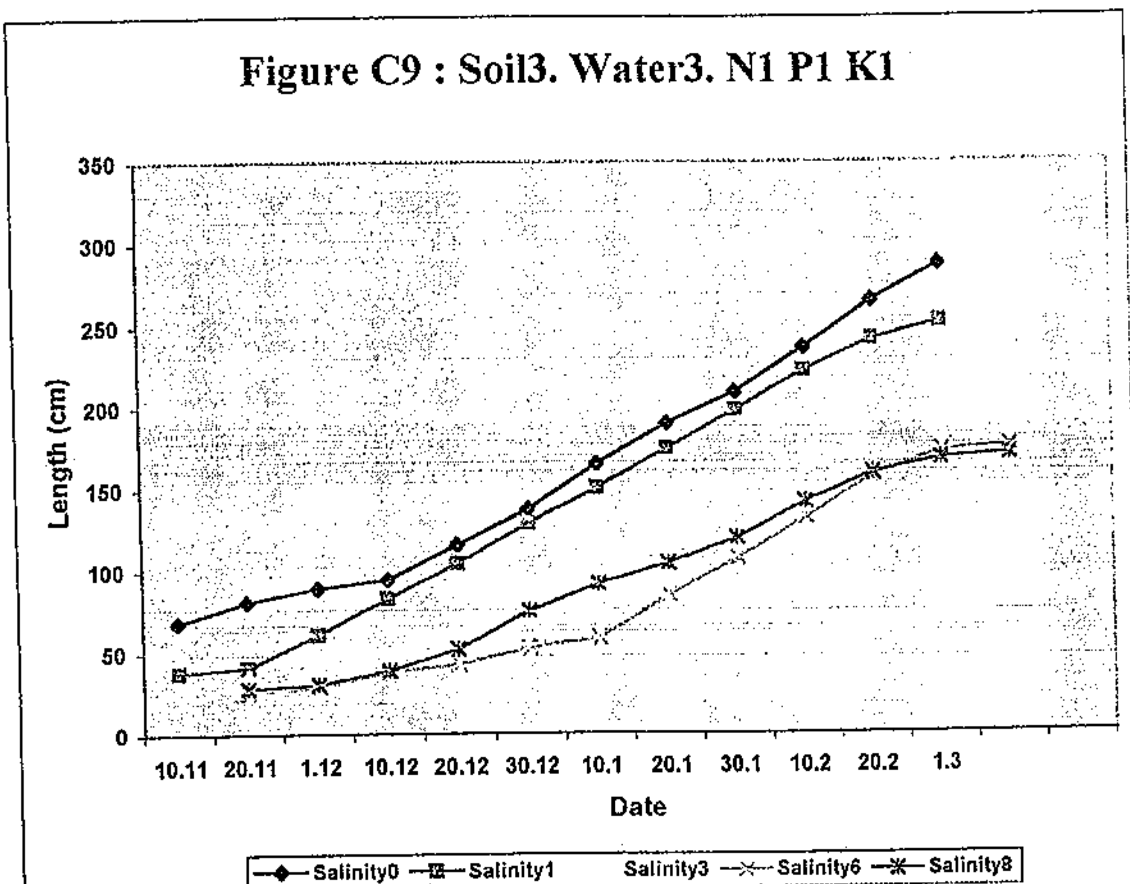
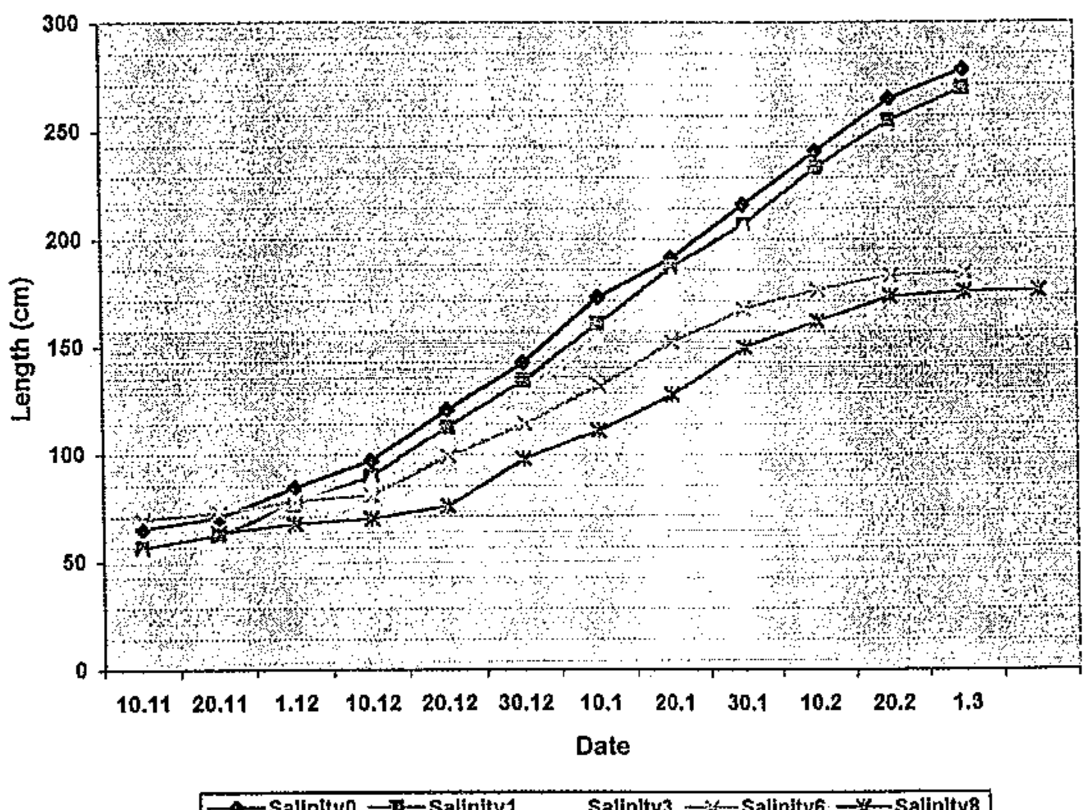


Figure C9 : Soil3. Water3. N1 P1 K1
350
300
250
200
150
100
50
0
Length (cm)
10.11 20.11 1.12 10.12 20.12 30.12 10.1 20.1 30.1 10.2 20.2 1.3
Date
Salinity0 Salinity1 Salinity3 Salinity6 Salinity8

Figure C10 : Soil1. Water12. N2 P1 K1



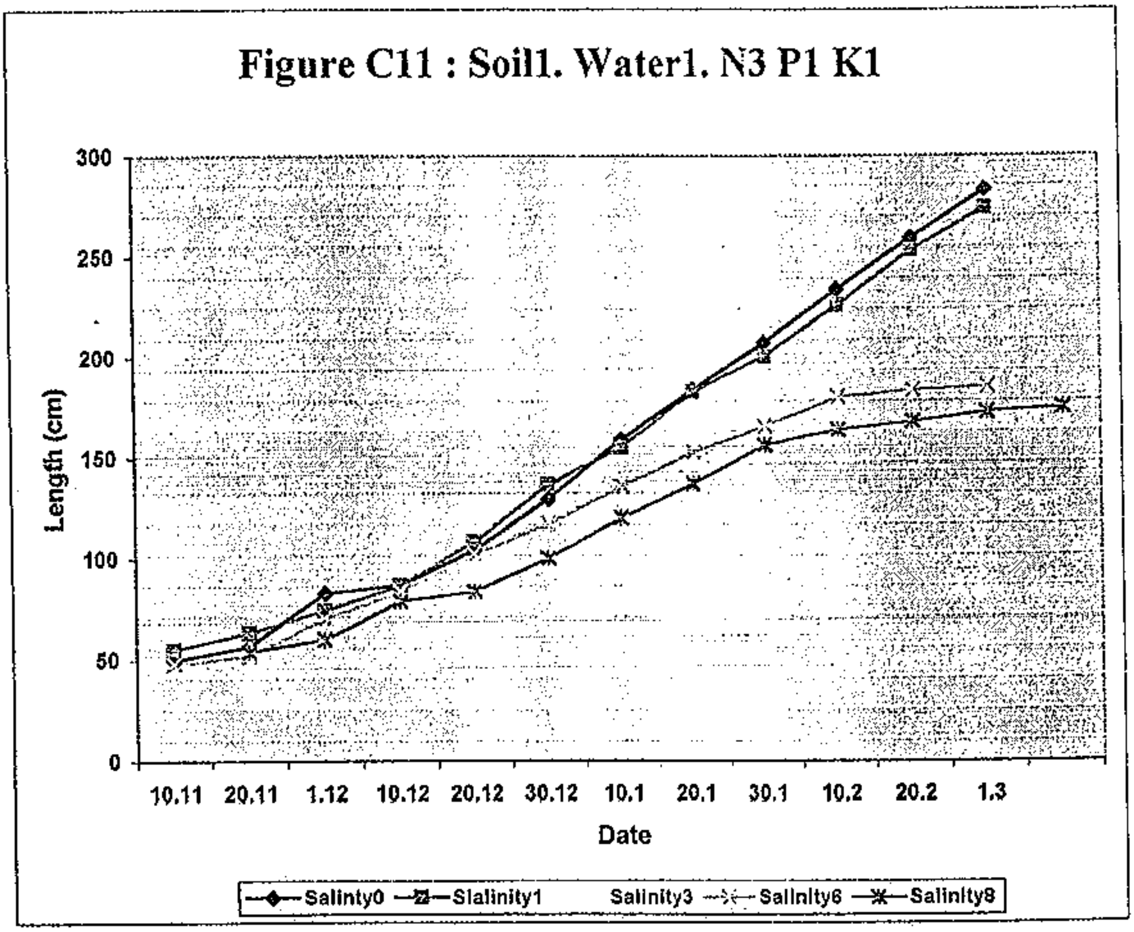


Figure C11 : Soil1. Water1. N3 P1 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinty0
Slalinity1
Salinity3
Salinity6
Salinity8

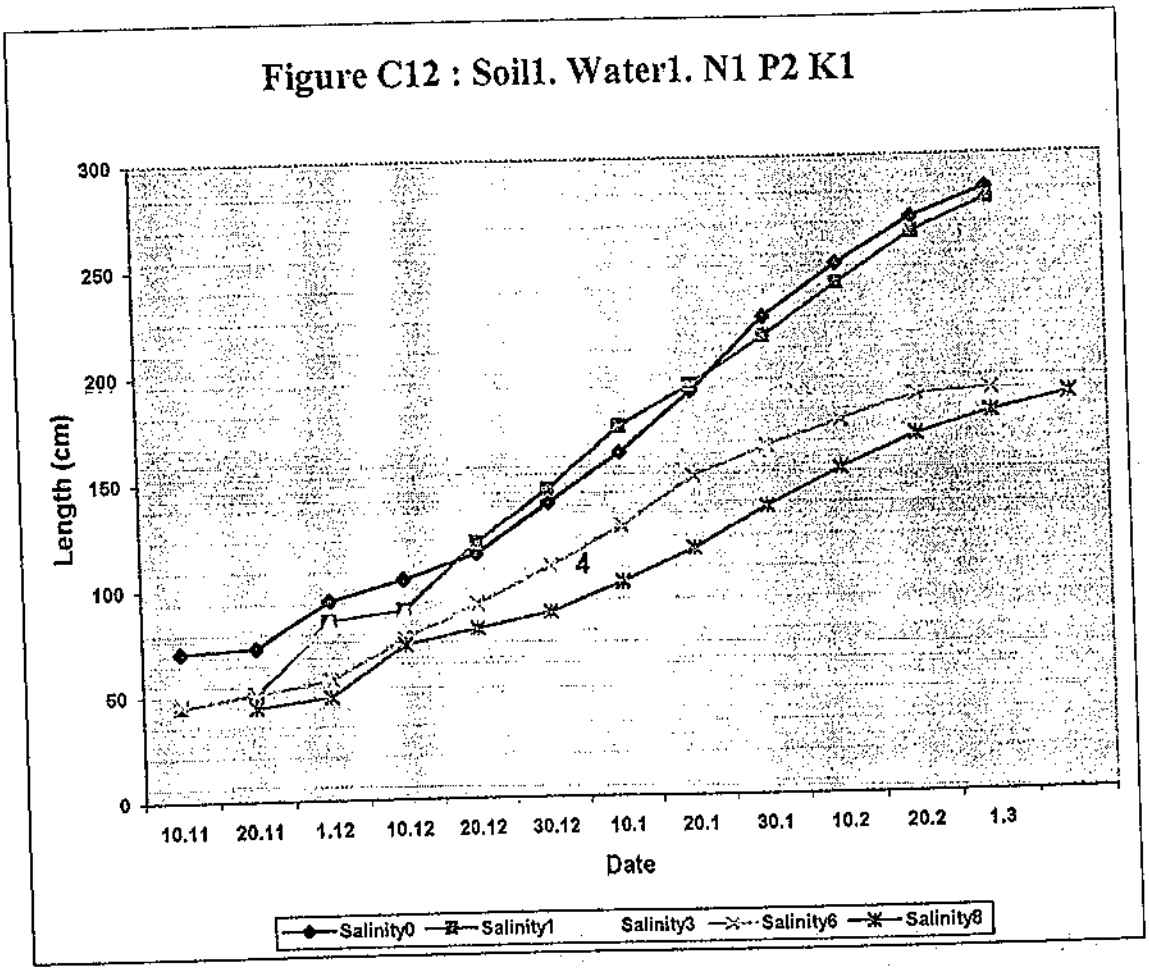


Figure C12 : Soil1. Water1. N1 P2 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
4
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

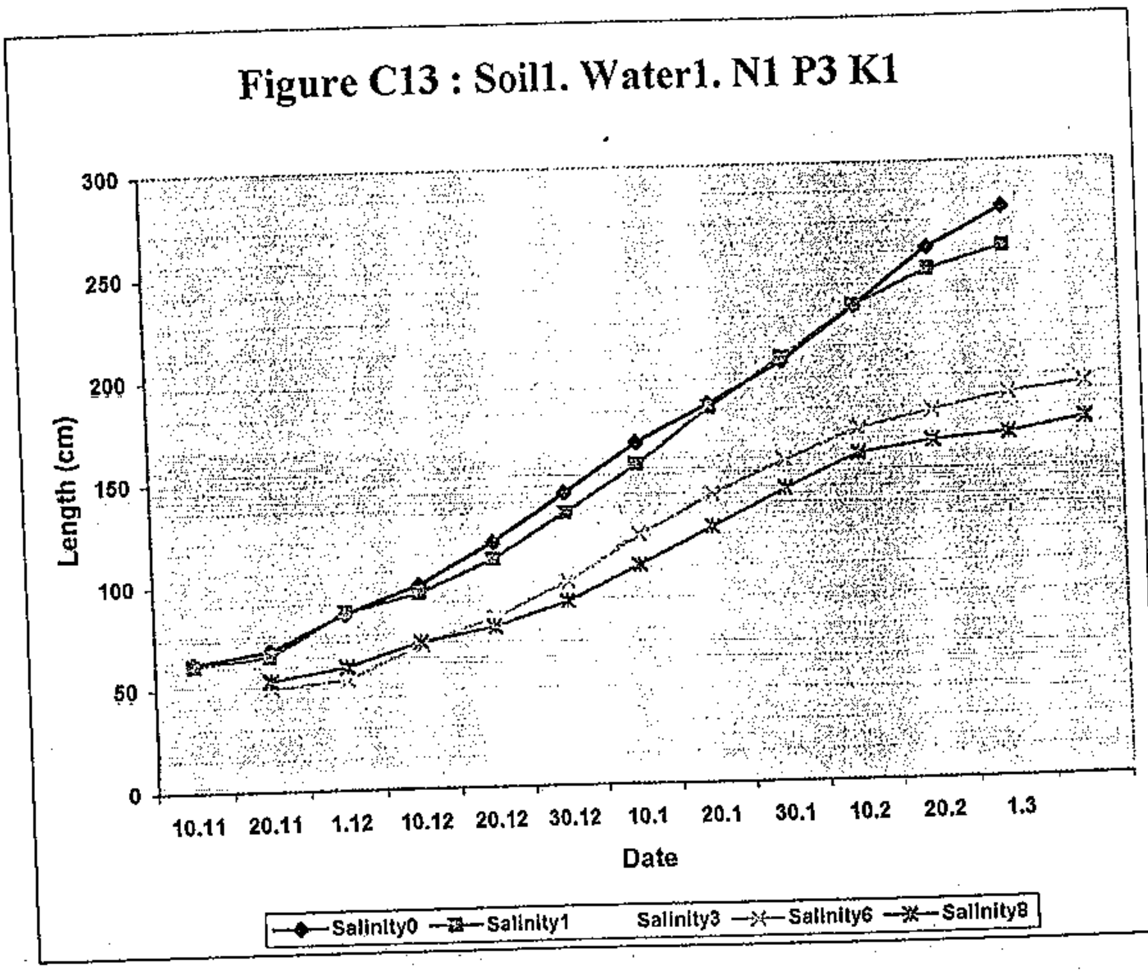


Figure C13 : Soil1. Water1. N1 P3 K1
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

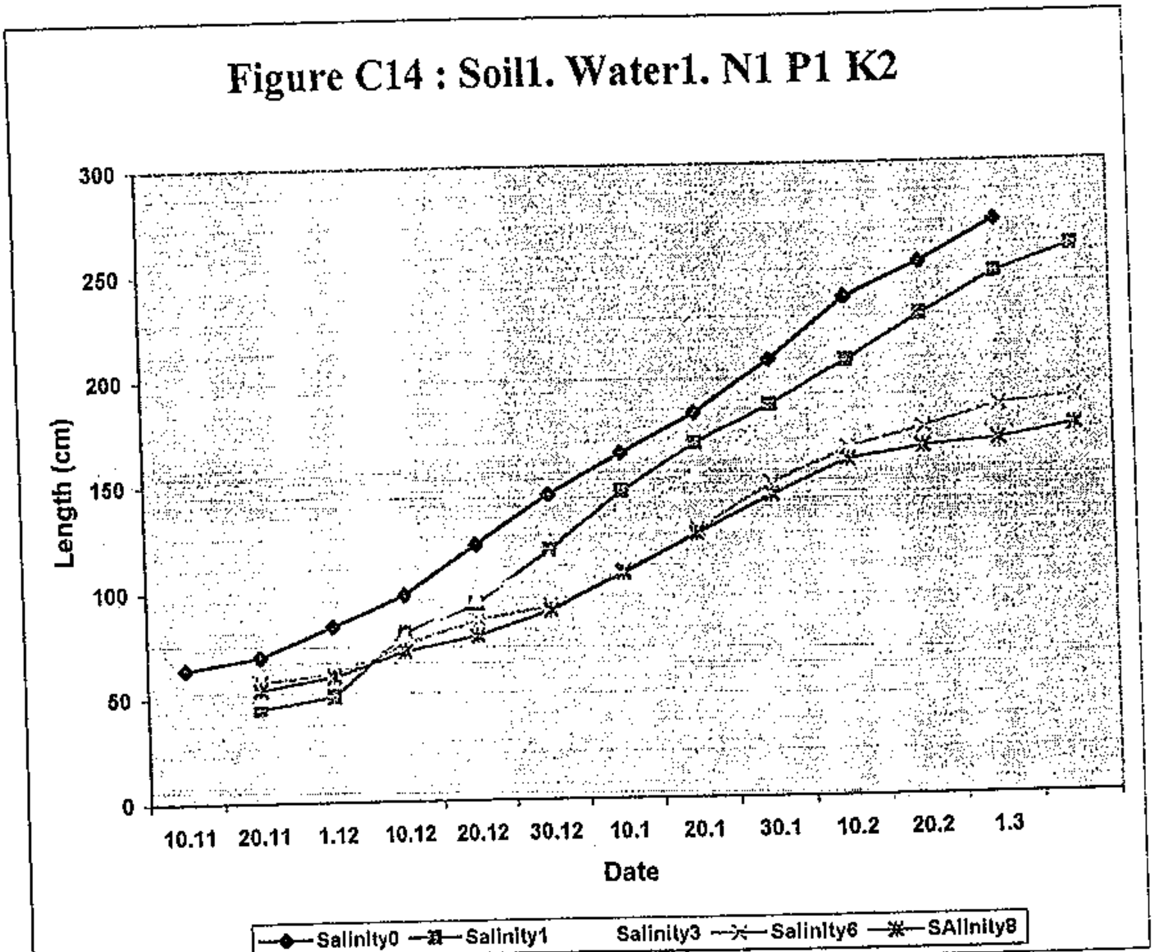


Figure C14 : Soil1. Water1. N1 P1 K2
300
250
200
150
100
50
0
Length (cm)
10.11
20.11
1.12
10.12
20.12
30.12
10.1
20.1
30.1
10.2
20.2
1.3
Date
Salinity0
Salinity1
Salinity3
Salinity6
SAlinity8

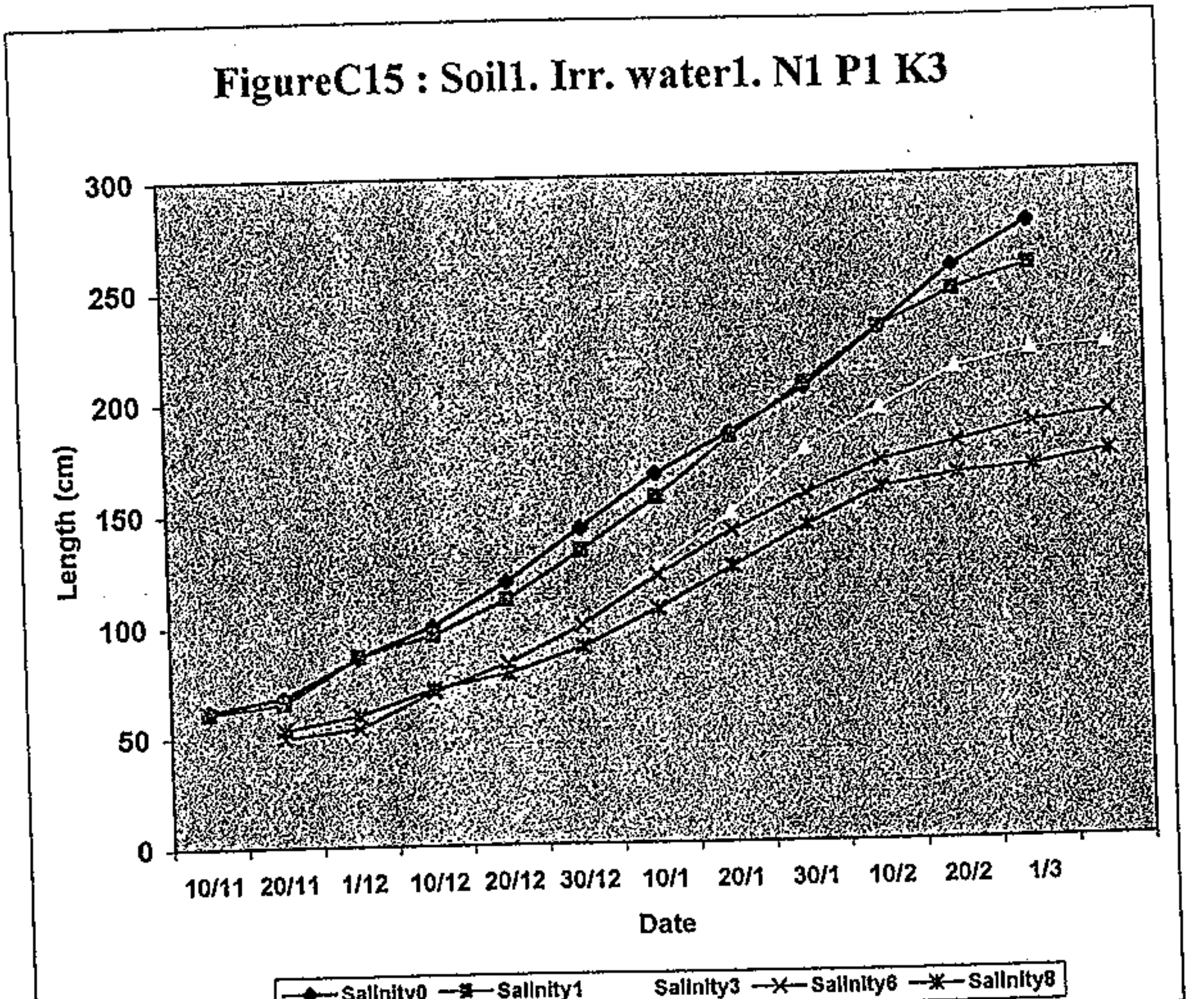
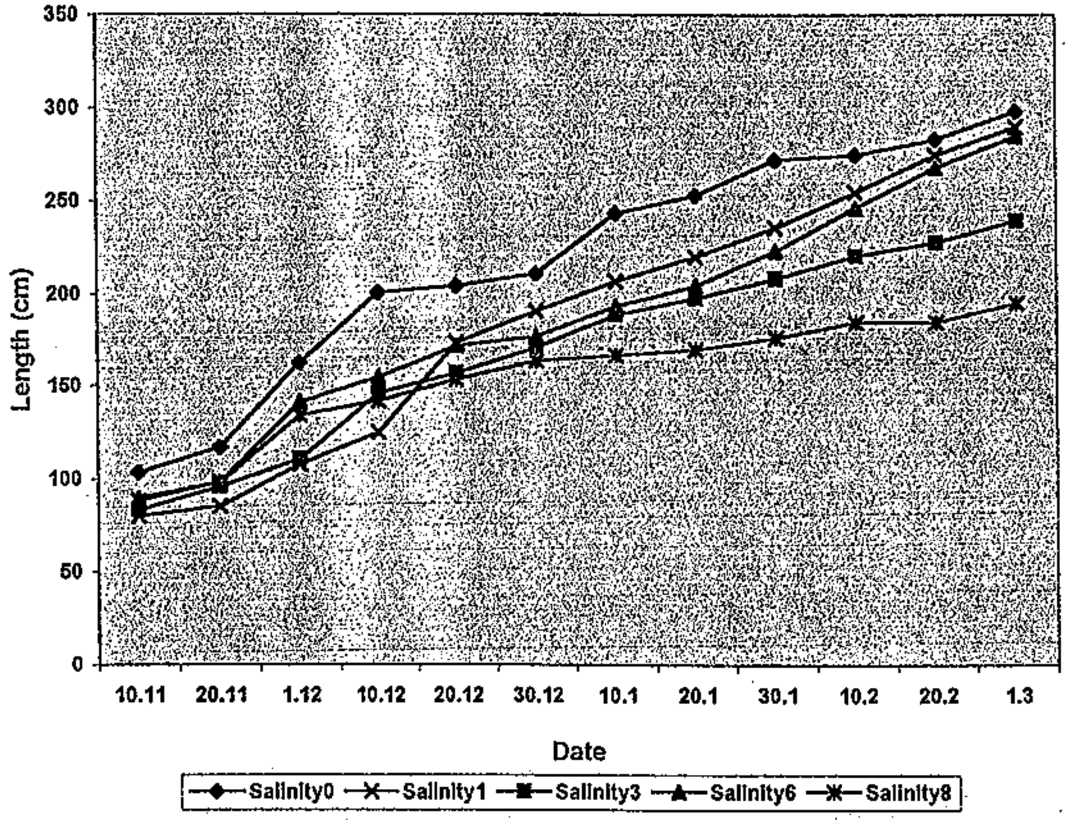

FigureC15 : Soil1. Irr. water1. N1 P1 K3
300
250
200
150
100
50
0
Length (cm)
10/11 20/11 1/12 10/12 20/12 30/12 10/1 20/1 30/1 10/2 20/2 1/3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

Figure C16: Soil1. Water1. N1 P1 K1with Mulch



7.4. Appendix (D)

Cherry Tomato Production Versus Time

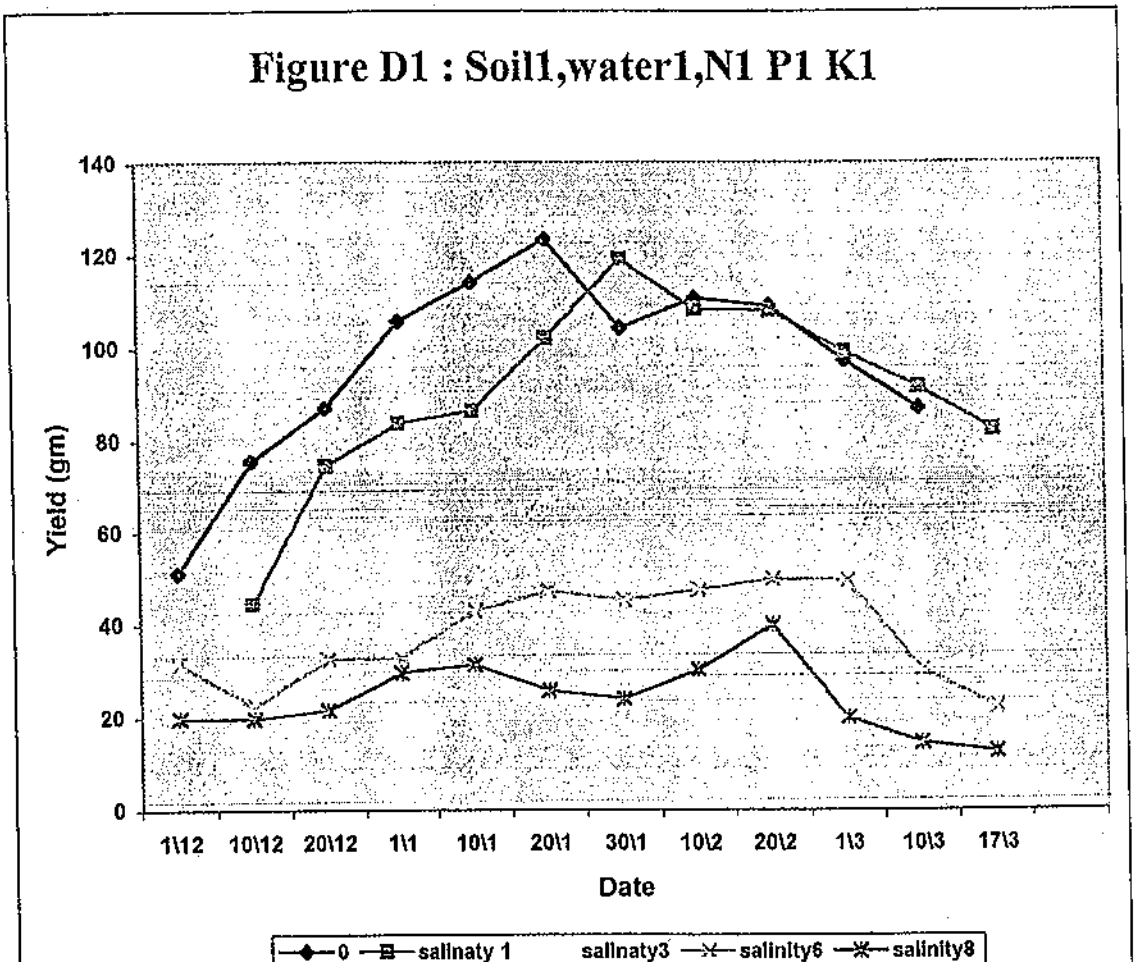
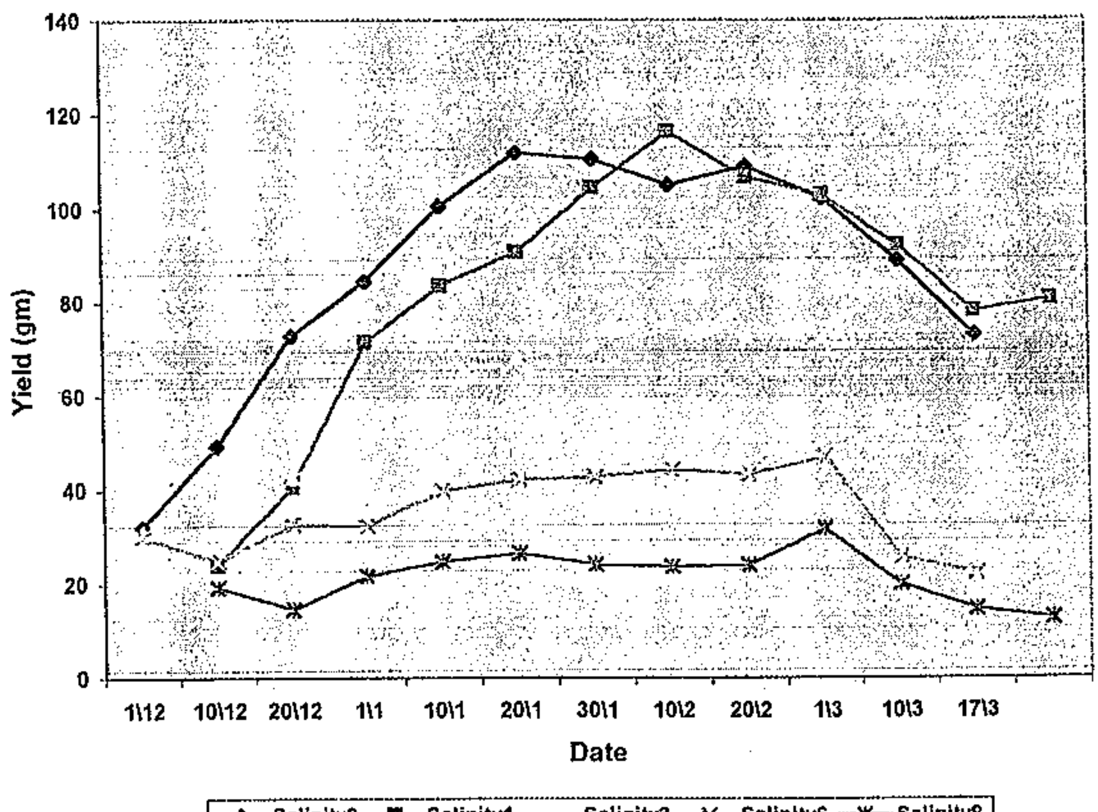


Figure D1 : Soil1,water1,N1 P1 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
0
salinaty 1
salinaty3
salinity6
salinity8

Figure D2 : Soil1.Water2.N1P1K1



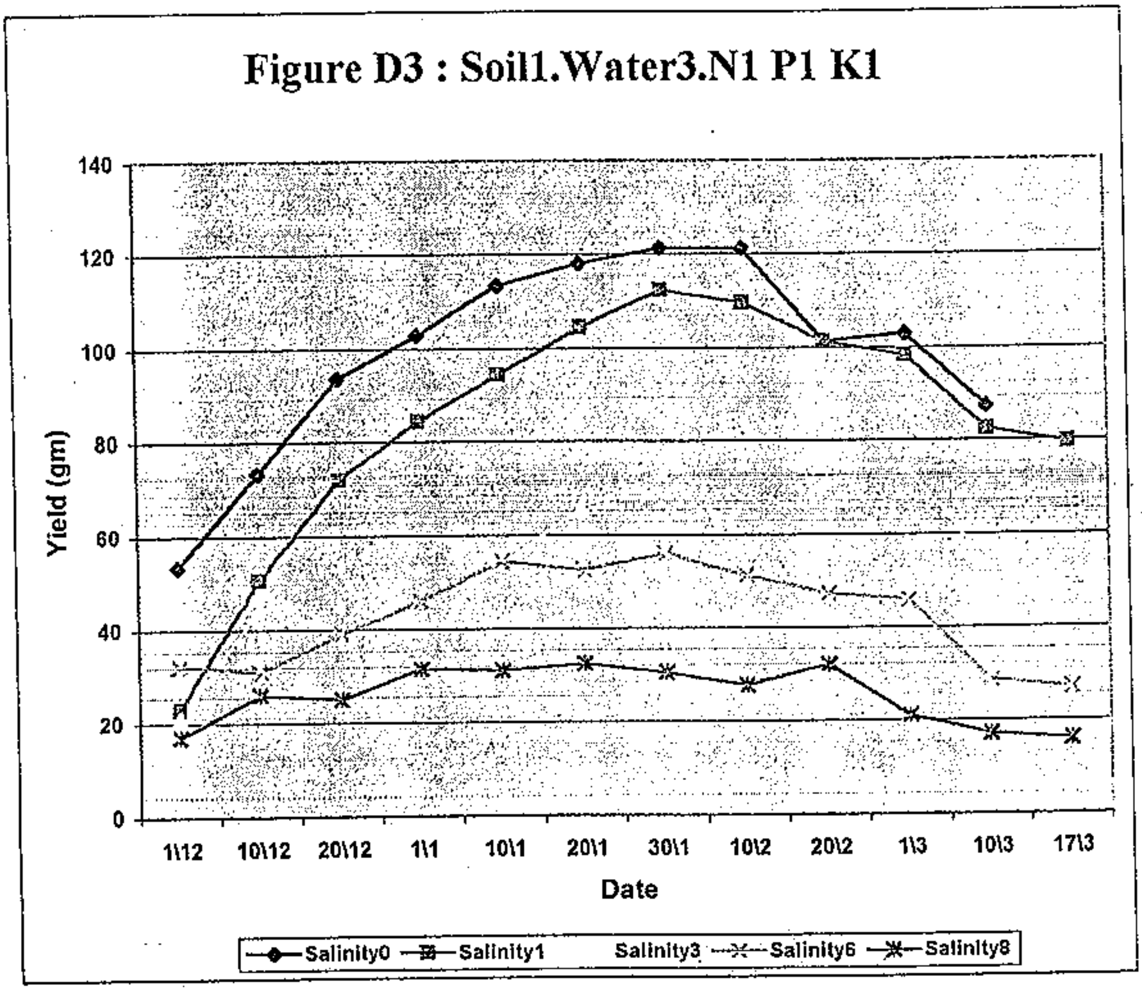


Figure D3 : Soil1.Water3.N1 P1 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

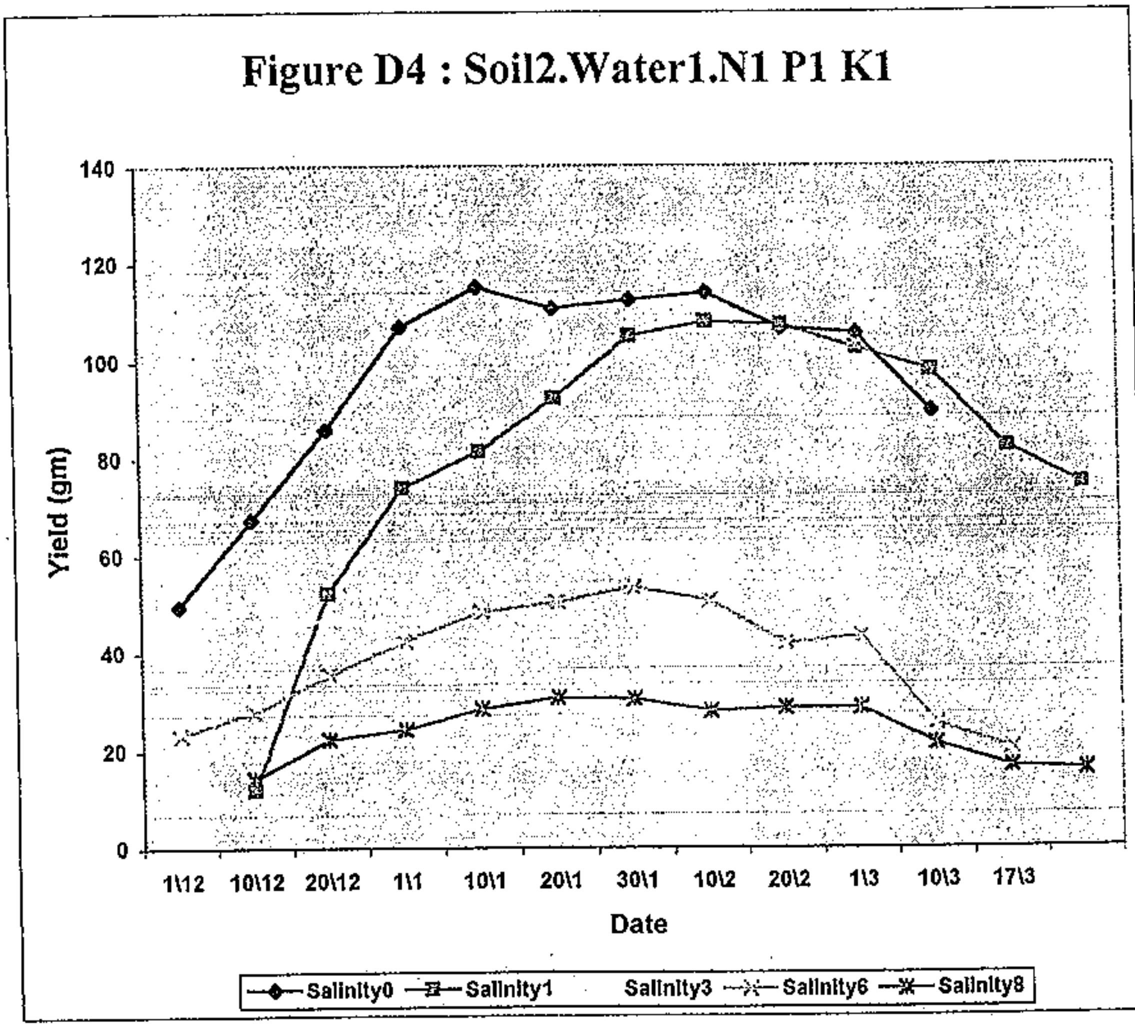


Figure D4 : Soil2.Water1.N1 P1 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

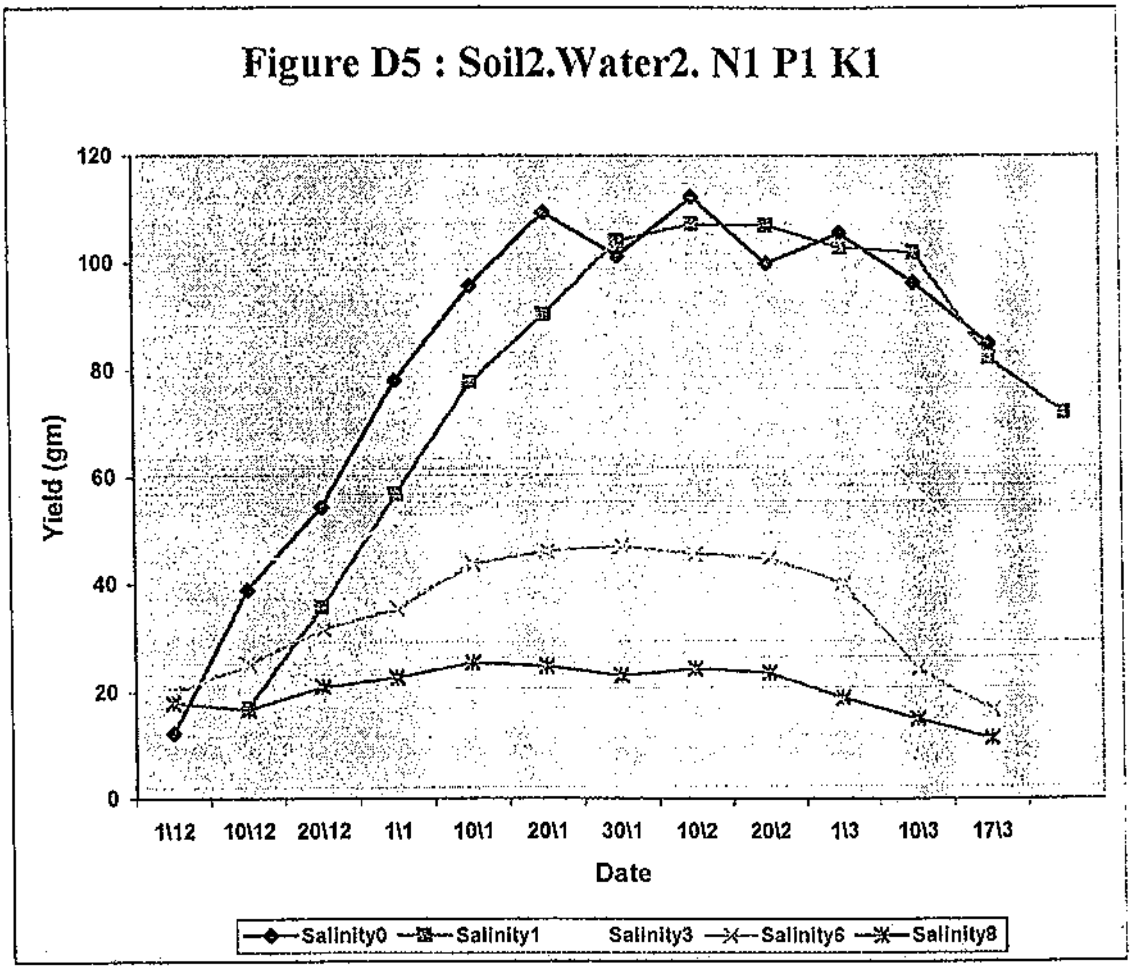
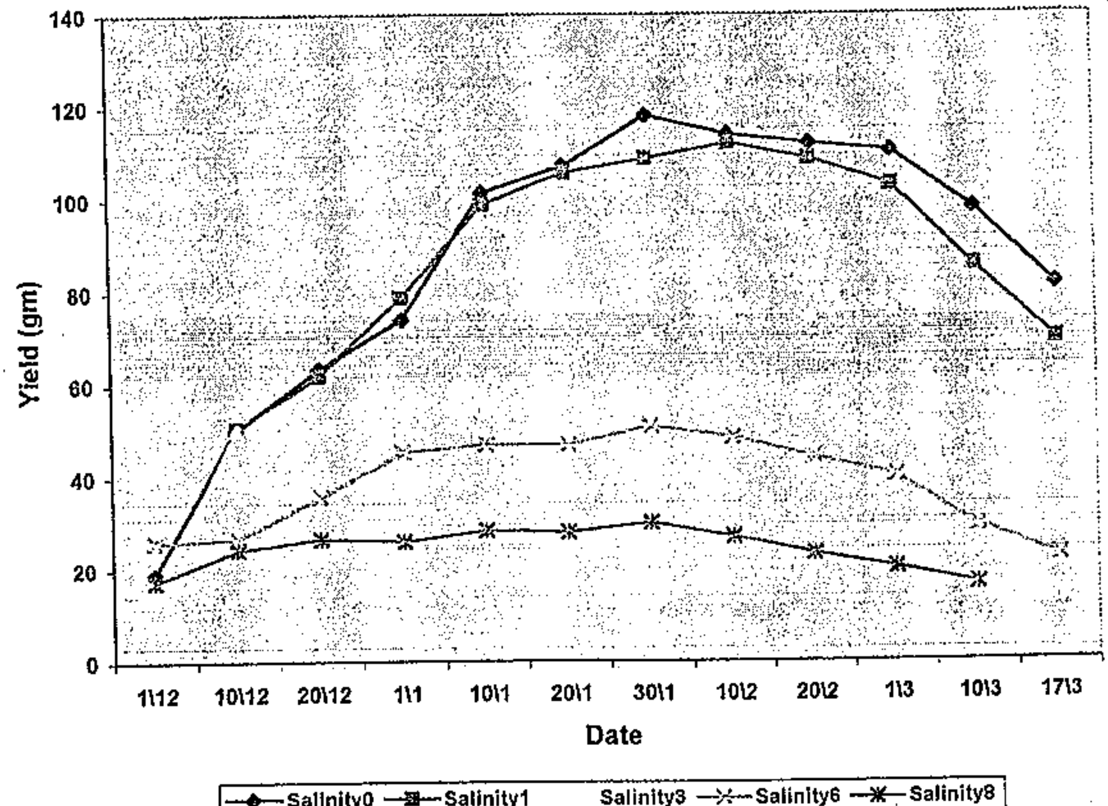


Figure D5 : Soil2.Water2. N1 P1 K1
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

Figure D6 : Soil2.Water3. N1 P1 K1



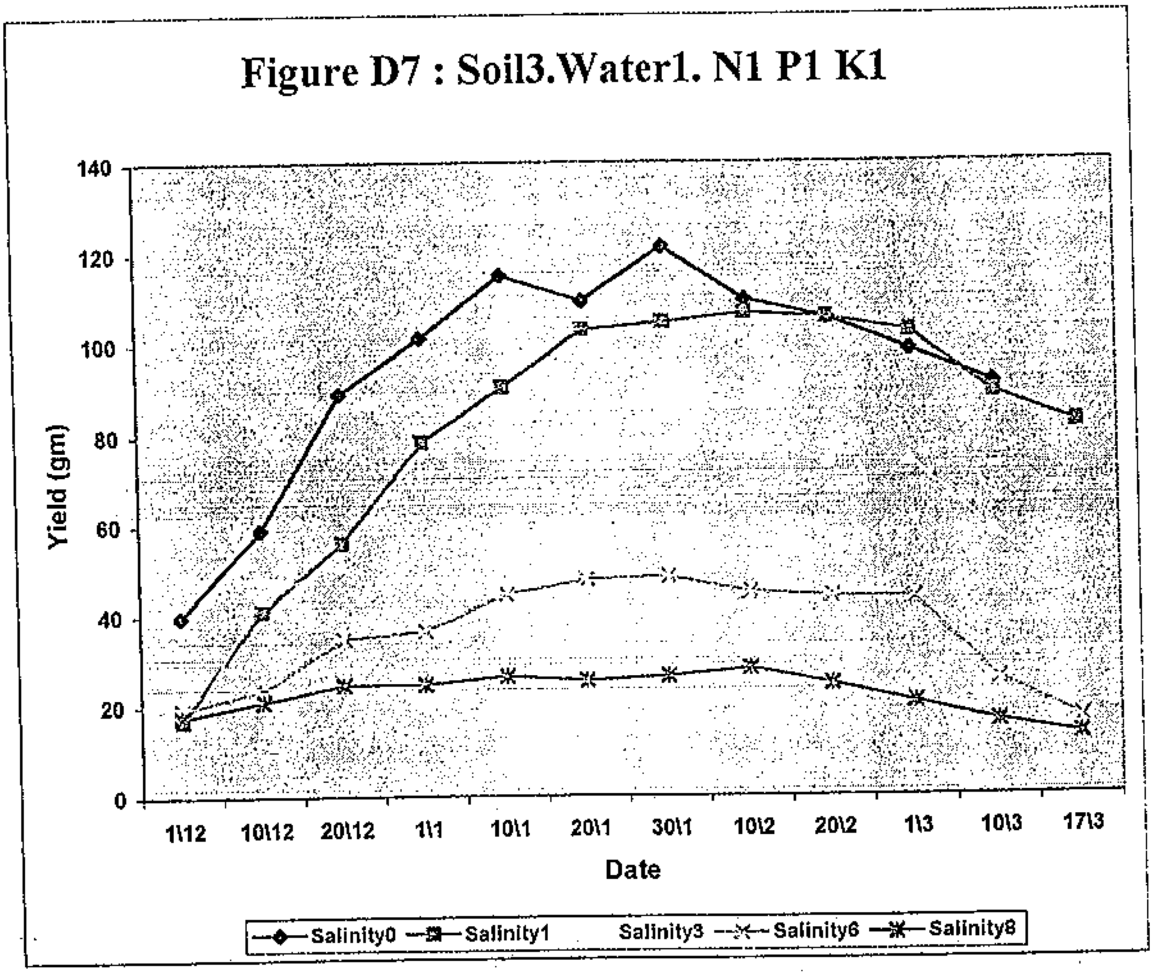


Figure D7 : Soil3.Water1. N1 P1 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

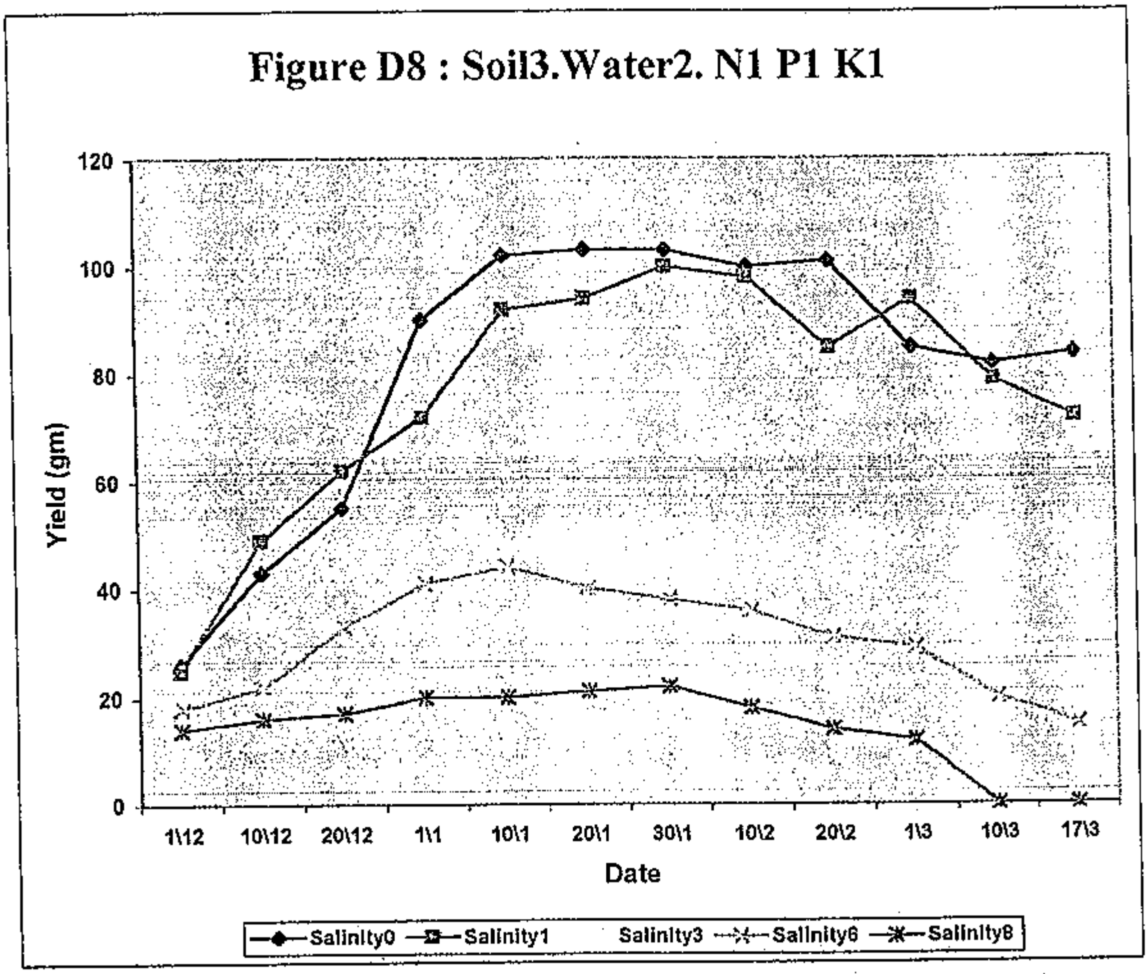


Figure D8 : Soil3.Water2. N1 P1 K1
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

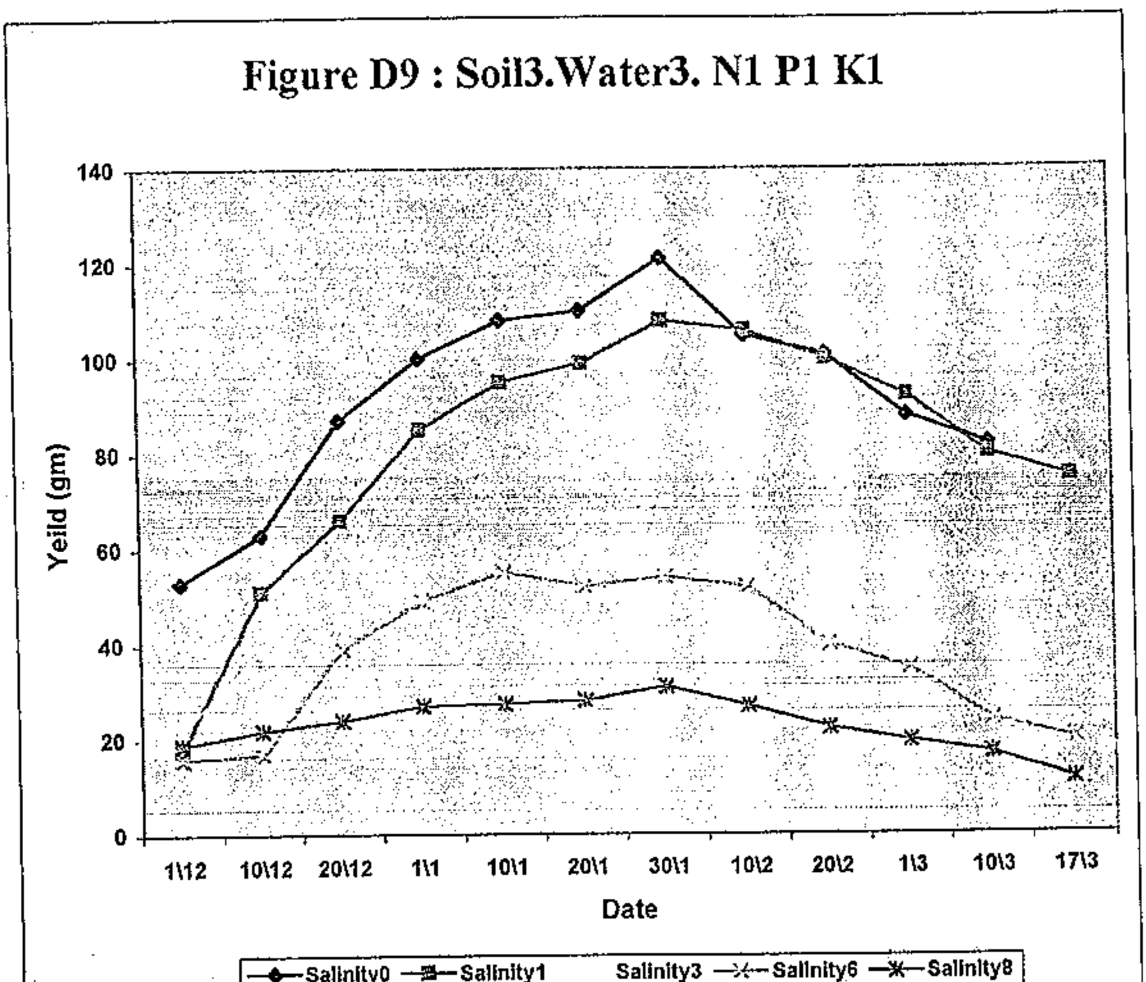


Figure D9 : Soil3.Water3. N1 P1 K1
140
120
100
80
60
40
20
0
Yeild (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

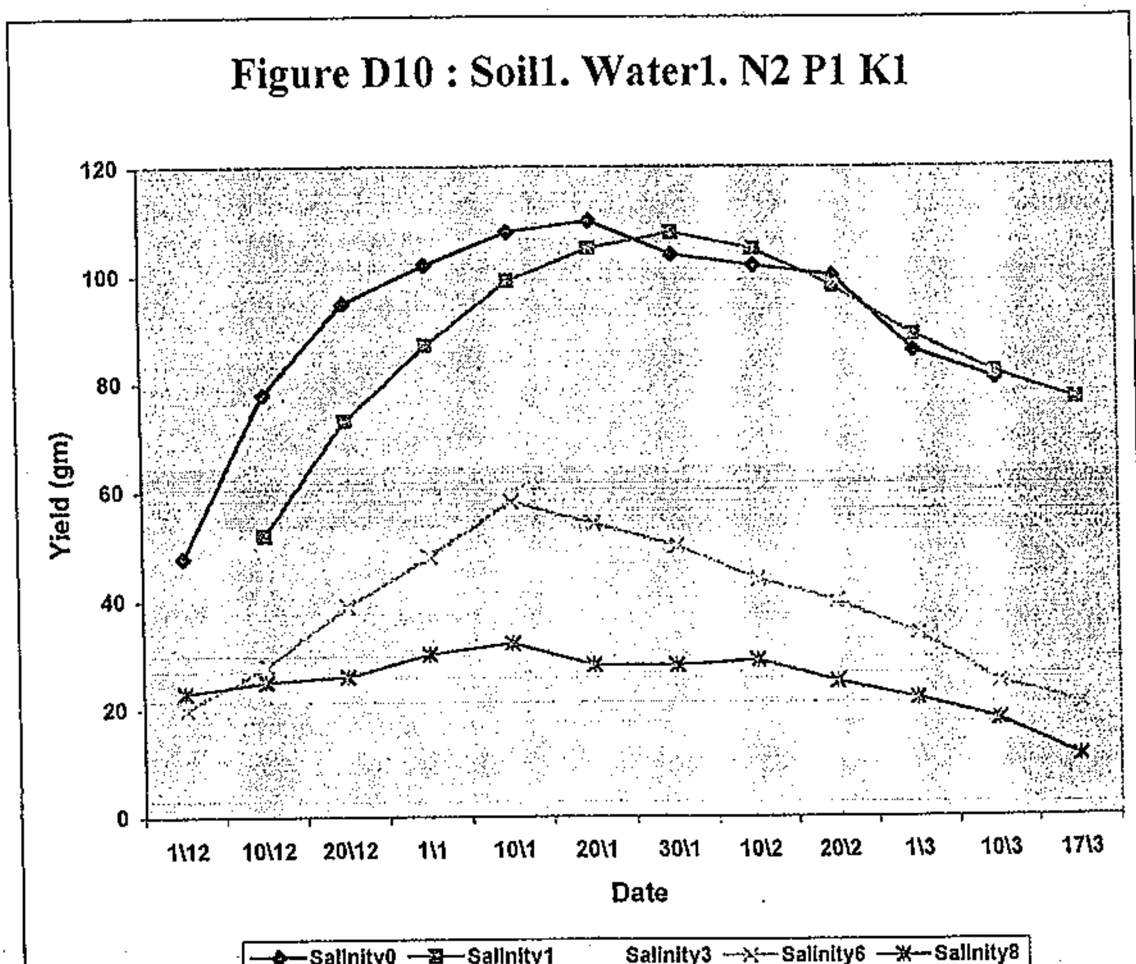
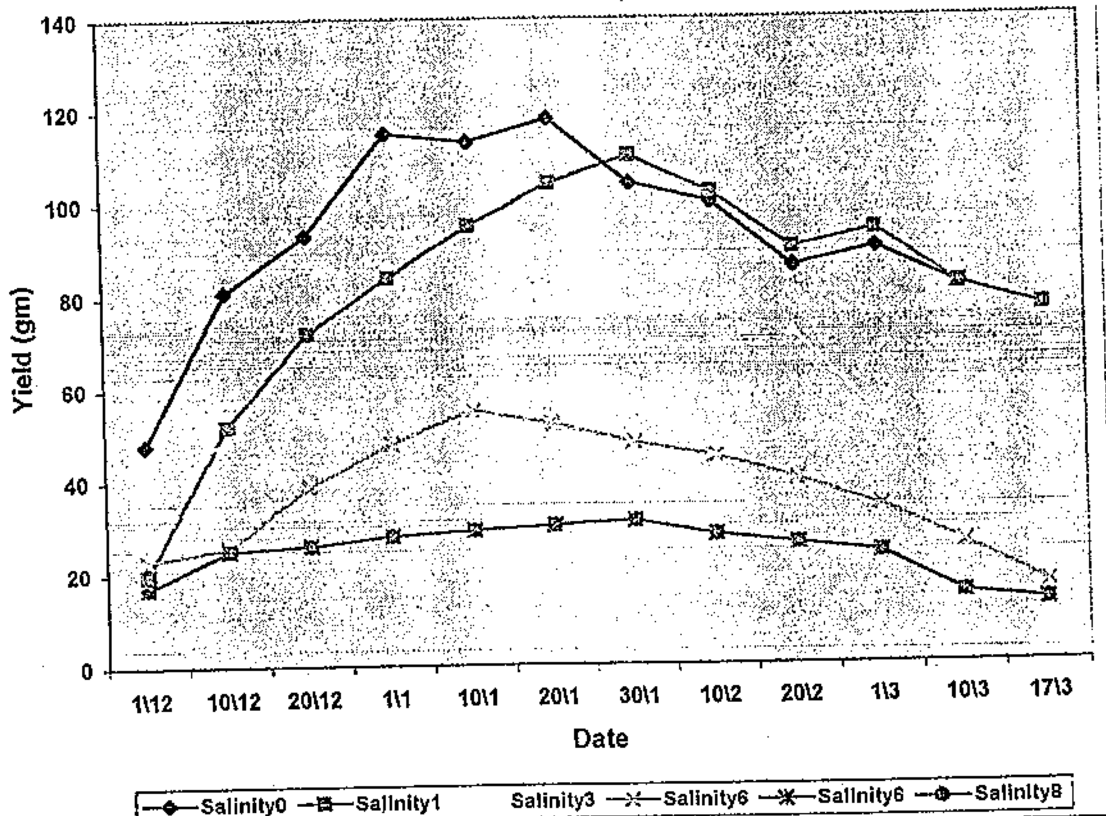


Figure D10 : Soil1. Water1. N2 P1 K1
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

Figure D11 : Soil1. Water1. N3 P1 K1



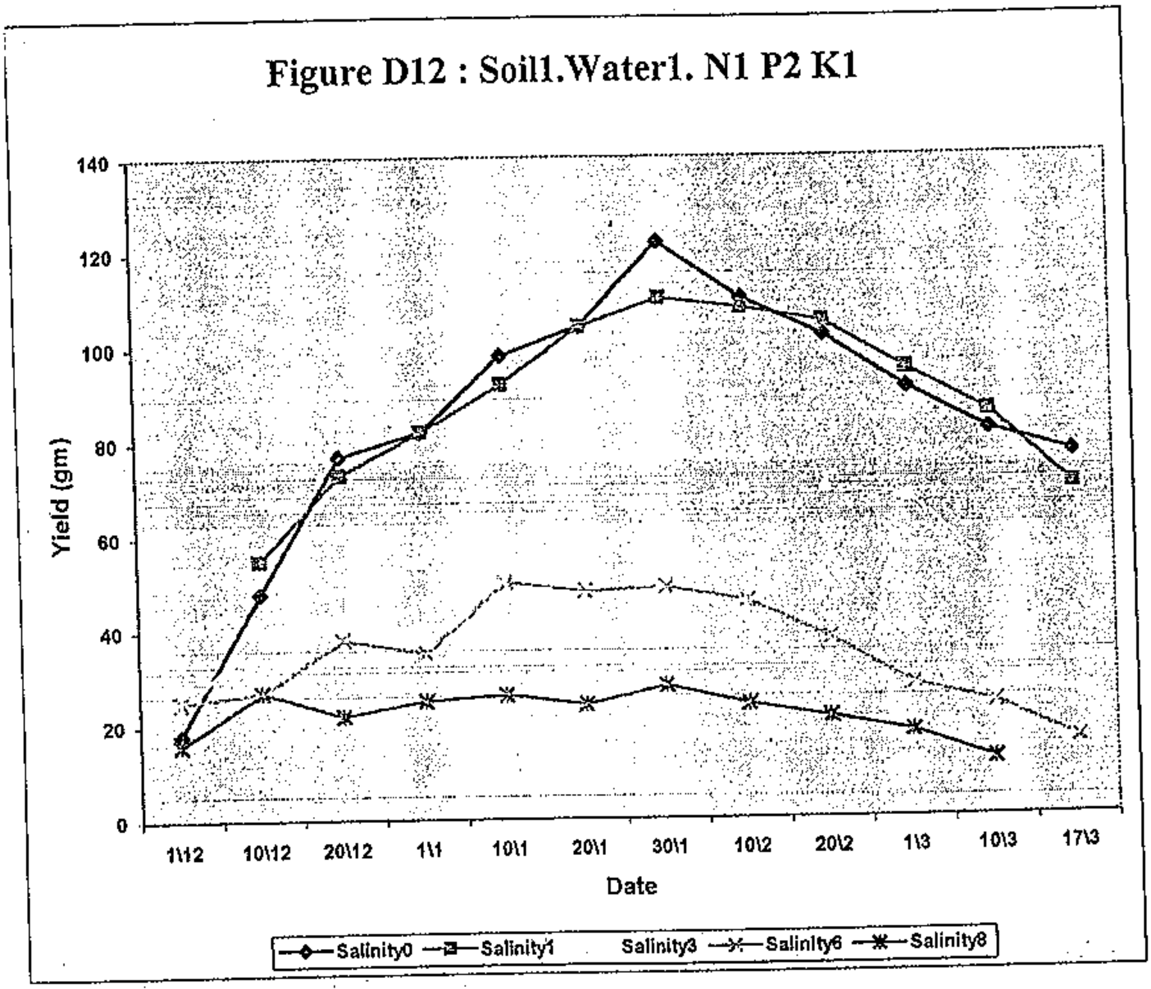


Figure D12 : Soil1.Water1. N1 P2 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

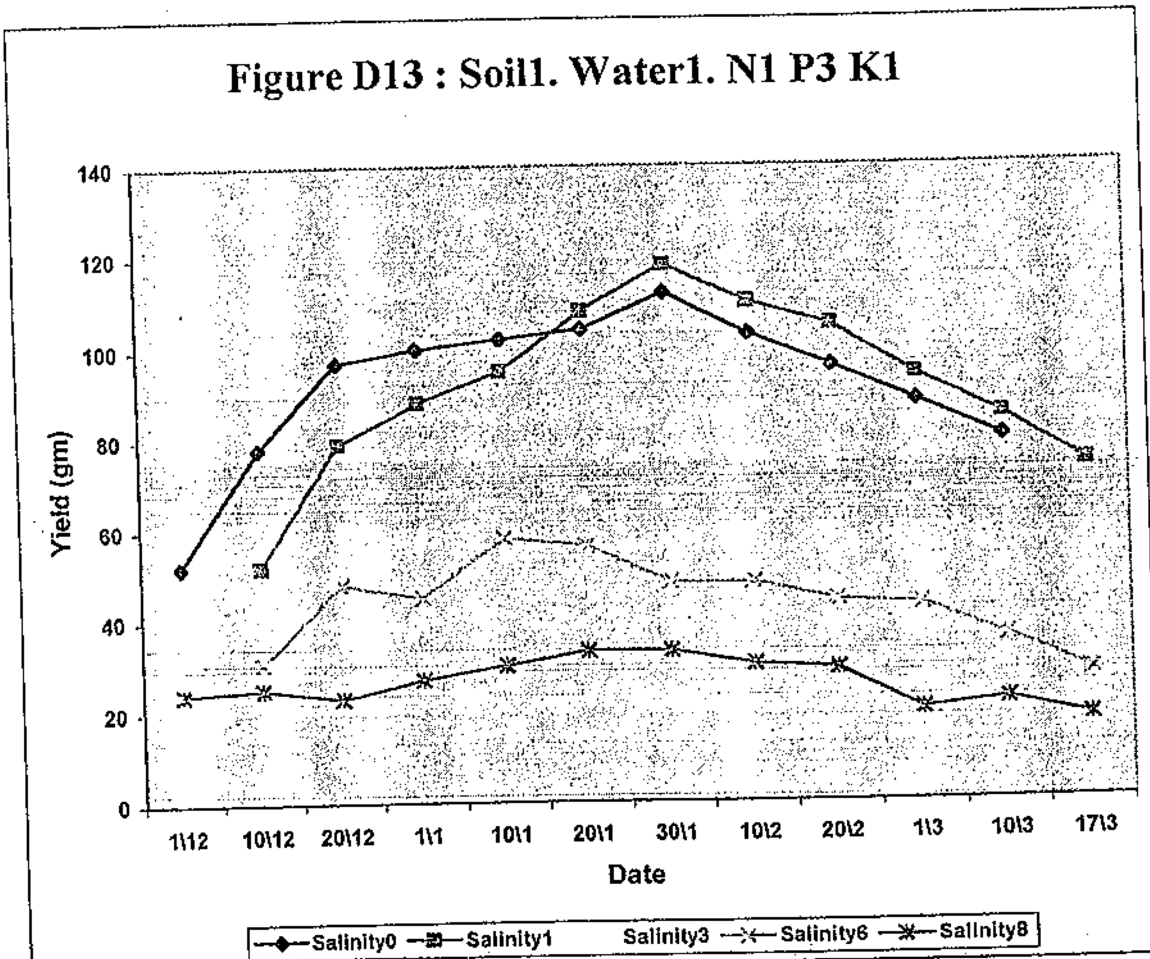
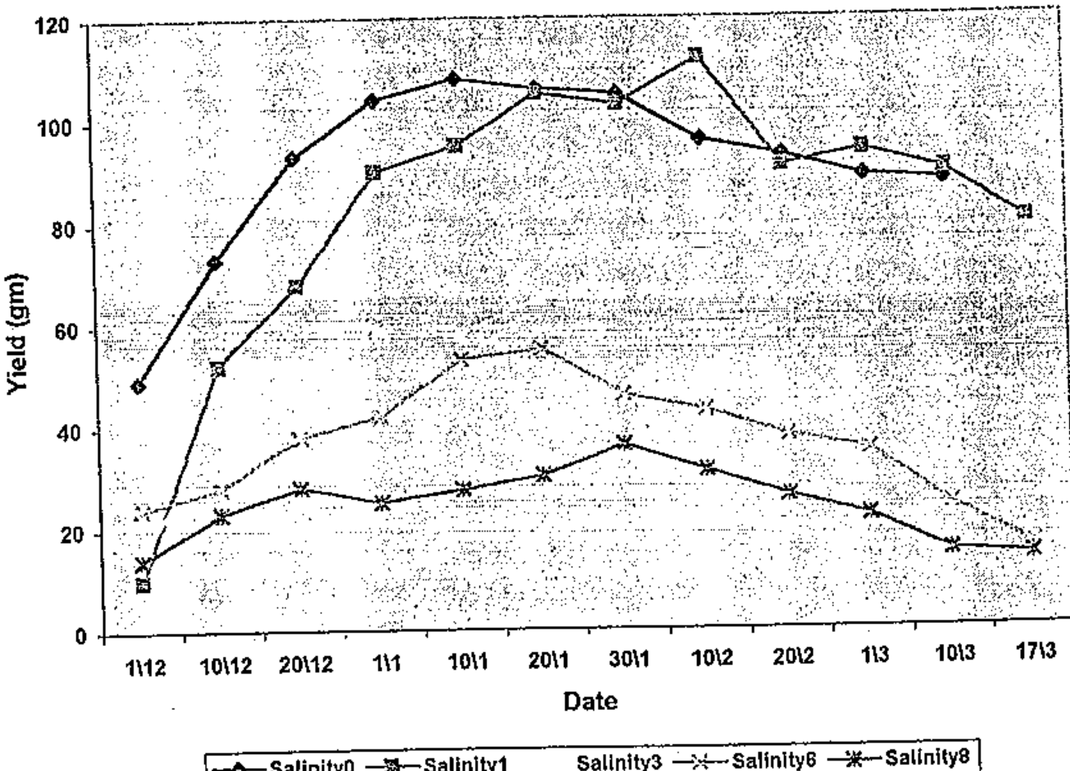


Figure D13 : Soil1. Water1. N1 P3 K1
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

Figure D14 : Soil1. Water1. N1 P1 K2



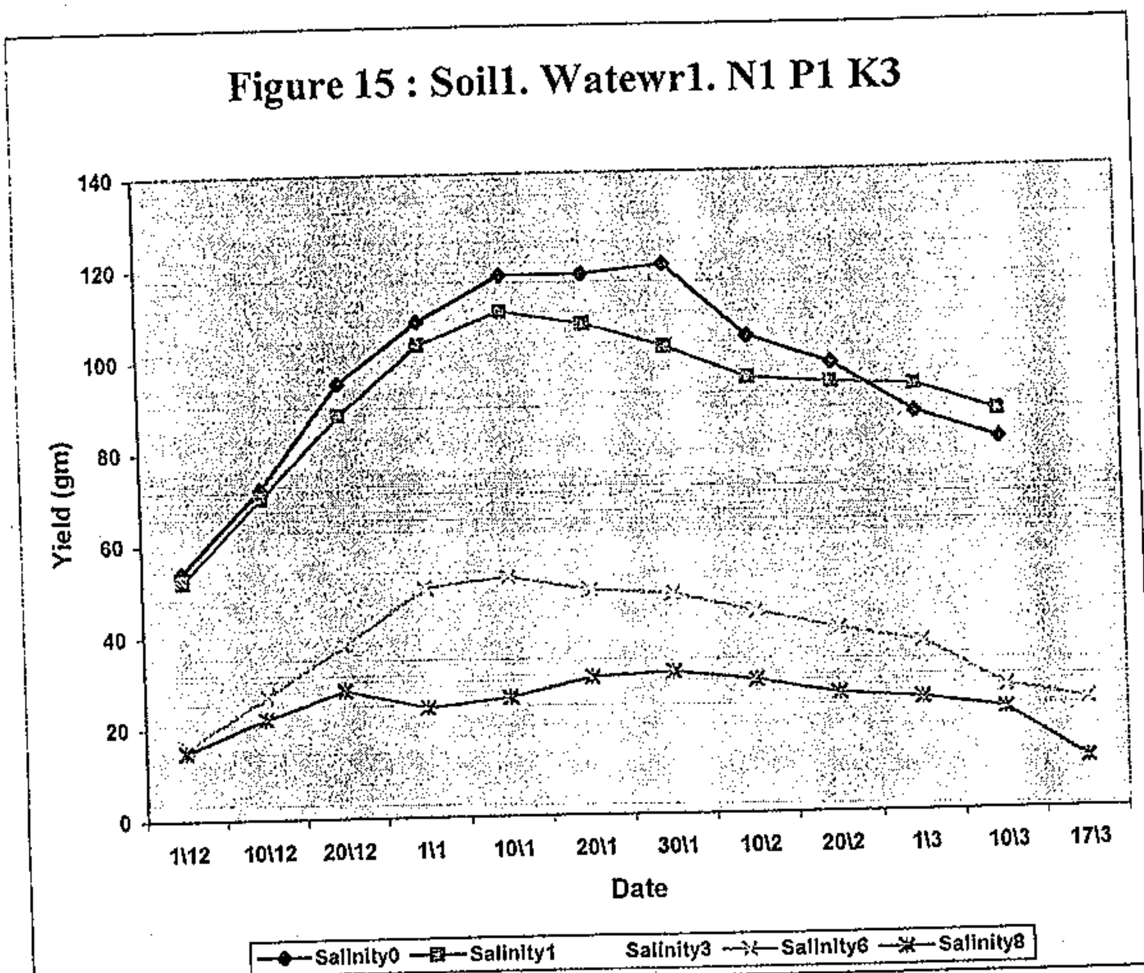


Figure 15 : Soil1. Watewr1. N1 P1 K3
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

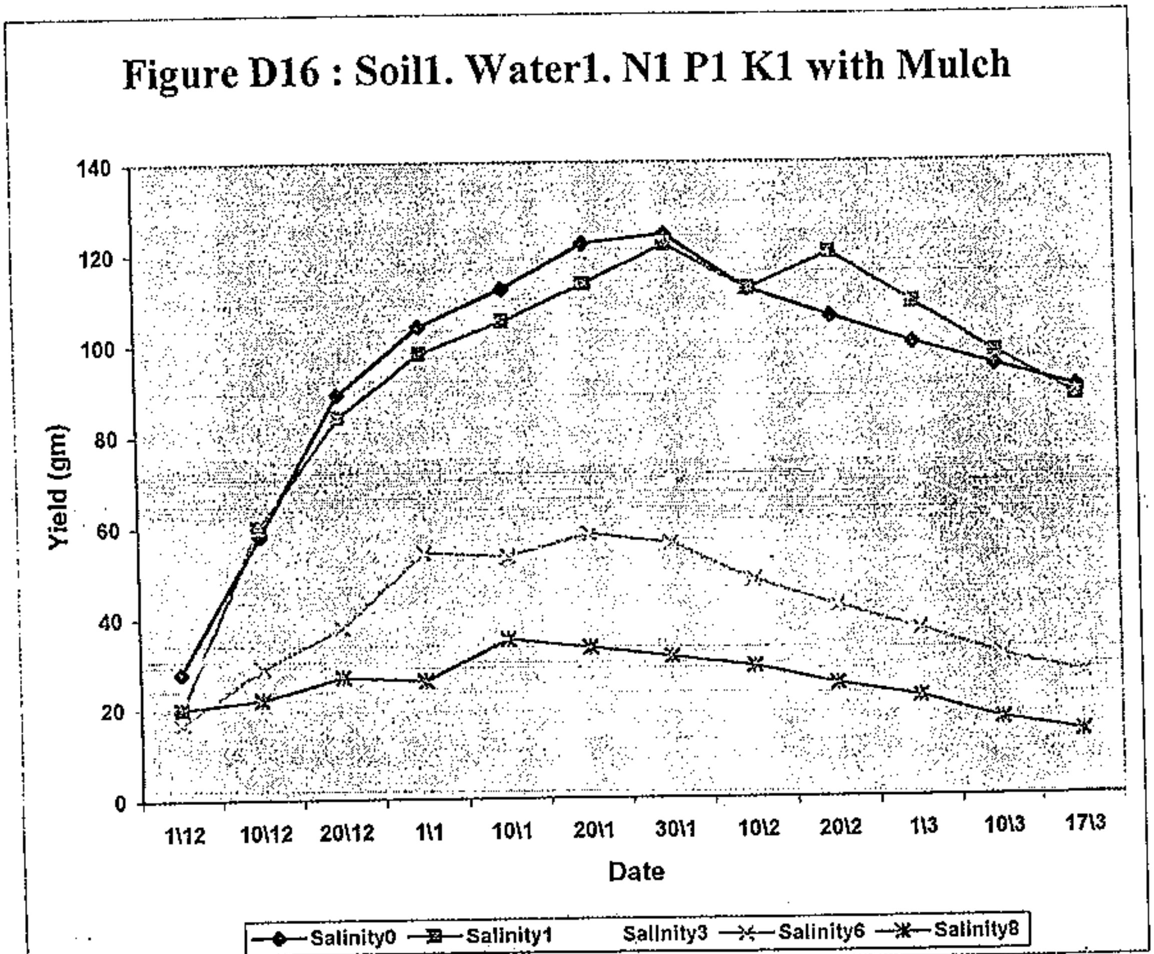


Figure D16 : Soil1. Water1. N1 P1 K1 with Mulch
140
120
100
80
60
40
20
0
Yield (gm)
1\12
10\12
20\12
1\1
10\1
20\1
30\1
10\2
20\2
1\3
10\3
17\3
Date
Salinity0
Salinity1
Salinity3
Salinity6
Salinity8

7.5. Appendix (E)

Summery Tables

Table E1 : TSS of Cherry Tomato fruit under different salinity levels and different treatments

salinity	TSS															
	Soil Type 1			Soil Type 2			Soil Type 3			soil Type 1						soil Type 1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	6	6	5.4	5.7	5.9	5.5	5.8	6.3	5	5.5	5	5.8	5.6	5.2	5.5	5.8
1	6.4	6.7	6.5	6.2	6.8	6.3	6.5	7	6	6.2	5.8	6.1	6.5	6.3	6.5	6.5
3	7.2	7.7	7.2	7.1	7.8	7	7.4	8	7.2	7.3	7	7.2	7	7.2	7.6	7.2
5	7.8	8.2	7.6	7.7	8.1	7.5	7.8	8.4	7.5	7.5	7.2	7.6	7.5	7.5	8	7.7
8	8.2	8.6	7.9	8.2	8.5	7.8	8.1	8.9	8	8.3	7.8	8.6	8.5	8.4	8.9	8.5

Table E2 : Yield of Cherry Tomato plant under different salinity levels and different treatments

salinity	yield/gm/plant															
	Soil Type.1			Soil Type.2			Soil Type.3			soil Type. 1						soil Type.1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulich cover
0	3200	3054.6	3225.8	3153.6	2980.4	3025.9	3109.6	2801.1	3047.6	3043.6	3086.3	3026.3	3025	3015	3212	3425
1	3000	2895	2987.6	2933.2	2752.3	2998.6	2911.3	2714.1	2980.3	2898	2905	2932	3047.5	2989	3002	3500.6
3	2050.8	1943.7	2037.8	2025.9	1920.7	2045.3	2068.8	1900	2098.6	2009.3	2000.1	1995.2	2100	1945	2006.5	2135.5
5	1375	1260.5	1448.9	1400	1250	1415.6	1272.2	1022.2	1385.6	1362.5	1320.6	1286.8	1540.3	1332.9	1341.6	1550
8	875	720	941.75	872.2	713.5	940	770.2	450	845.8	878.9	880.6	754	932	850	840	920.8

Table E3 : Titrable acidity of Cherry Tomato fruit under different salinity levels and different treatments

salinity	Titrable acidity %															
	Soil Type 1			Soil Type 2			Soil Type 3			soil Type 4						soil Type 1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	0.52	0.55	0.5	0.53	0.58	0.5	0.58	0.6	0.59	0.52	0.53	0.54	0.55	0.54	0.56	0.57
1	0.61	0.64	0.62	0.62	0.65	0.63	0.68	0.69	0.66	0.63	0.65	0.67	0.68	0.67	0.65	0.66
3	0.74	0.75	0.73	0.74	0.75	0.75	0.78	0.8	0.78	0.78	0.76	0.77	0.79	0.78	0.79	0.76
5	0.83	0.85	0.83	0.85	0.82	0.84	0.85	0.89	0.88	0.86	0.85	0.84	0.87	0.85	0.88	0.87
8	0.89	0.92	0.88	0.9	0.91	0.92	0.91	0.95	0.92	0.89	0.9	0.91	0.92	0.91	0.94	0.93

Table E4 : PH of Cherry Tomato fruit under different salinity levels and different treatments

salinity	PH															
	Soil Type 1			Soil Type 2			Soil Type 3			soil Type 1						soil Type 1
	Ir. Water 1	Ir. Water 2	Ir. Water 3	Ir. Water 1	Ir. Water 2	Ir. Water 3	Ir. Water 1	Ir. Water 2	Ir. Water 3	N2	N3	J2	P3	K2	K3	Mulch cover
0	3.98	3.89	3.97	3.95	3.9	3.96	4	4	3.94	4	4.02	3.95	3.99	3.97	3.95	3.98
1	4.04	3.88	4	3.99	3.95	3.99	4.1	3.96	3.95	4.02	4.04	3.95	3.98	3.99	3.96	3.96
3	4.04	3.94	3.98	3.88	4.04	4	4.08	3.96	3.99	4.03	4.09	4.02	4.02	4.01	4	4
5	4.06	4	4	4.03	4	4	4.08	4.02	4.02	4.2	4	4.05	4.02	4	4.02	4.04
8	4.06	4	4.02	4.01	4	4	4.1	4.05	4.06	4.06	4.08	4.02	4.01	4.02	4.02	4.03

Table E5 : Reducing suger content of Cherry Tomato fruit under different salinity levels and different treatments

salinity	Reducing sugar (gm/100ml sap)														
	Soil Type 1			Soil Type 2			Soil Type 3			soil Type 4					Soil Type 4
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	3.39	3.48	3.43	3.35	3.6	3.35	3.4	3.65	3.38	3.4	3.38	3.45	3.39	3.42	3.4	3.41
1	3.65	3.68	3.65	3.58	3.78	3.81	3.84	3.8	3.75	3.8	3.85	3.78	3.78	3.8	3.85	3.82
3	3.91	3.98	3.92	3.97	4	3.98	3.96	4	3.95	3.96	4	3.98	4.02	3.92	3.98	3.97
5	4.2	4.25	4.14	4.19	4.23	4.21	4.26	4.3	4.28	4.23	4.31	4.32	4.35	4.34	4.39	4.33
8	4.4	4.6	4.42	4.5	4.65	4.45	4.5	4.6	4.55	4.42	4.54	4.5	4.58	4.52	4.57	4.56

Table E6 : Vitamin C content of Cherry Tomato fruit under different salinity levels and different treatments

salinity	Vitamin C (ascorbic acid) mg /100ml fw															
	Soil Type.1			Soil Type.2			Soil Type.3			soil Type . 1						soil Type.1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	19.2	19.5	19.3	18.9	19.5	19.2	19	19.5	19.1	19.3	19.2	19.3	19.4	18.95	19	19.1
1	19.5	20	19.8	19.5	20	20.3	19.8	20	19.9	19.8	20	19.95	19.9	19.85	19.84	20
3	20	20.5	20.3	20.2	20.8	20.7	20.9	20.9	20.85	20.74	20.88	20.95	20.75	20.8	20.9	20.65
5	21	21.6	21.2	21.5	22	21.4	21.5	21.6	21.5	21.7	21.8	21.86	21.68	21.7	21.87	21.68
8	23	23.3	22.5	23	23.5	23	23.2	24	23.2	23.4	23	23.3	23.2	23	23.4	23.2

Table E7 : Dry matter of Cherry Tomato shoot under different salinity levels and different treatments

salinity	% Dry matter / shoot															
	Soil Type 1			Soil Type 2			Soil Type 3			Soil Type 1						Soil Type 1
	Ir. Water 1	Ir. Water 2	Ir. Water 3	Ir. Water 1	Ir. Water 2	Ir. Water 3	Ir. Water 1	Ir. Water 2	Ir. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	14	14.5	13.7	15	15.6	14.8	15	15.2	14.7	14.5	13.24	13.9	14.5	14.23	15.15	13.5
1	15.2	16	15.5	17	16.8	16.7	16.78	17.5	15.32	16.25	15.32	16.5	17.2	17	16.3	16
3	18	18.35	17.8	18.5	19	19.2	18.9	19.5	19	19.2	18.7	19.8	18.9	19	19.17	18.5
5	19.2	19.5	19	20.2	20.2	20	20.14	20.5	20.35	20.15	19.35	19.84	19.5	20.1	20	19.29
8	20	21	20.3	20.5	20.8	20.6	21	21.3	20.58	20.27	20	20.65	20.8	20.5	20.8	20.1

Table E8 : Dry matter of Cherry Tomato root under different salinity levels and different treatments

salinity	% Dry matter / Root															
	Soil Type 1			Soil Type 2			Soil Type 3			soil Type 1						soil Type 1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	18	18	17.5	17.8	18	17.5	19	19.25	18.5	18	17.2	17.9	18.5	18.24	18.8	19
1	19	19.2	18.8	19	19.2	18.7	19.5	20	19.85	19	19.5	19.6	19.35	19.2	19.5	19
3	20.34	20.8	20.2	19.85	20	19.2	21	21.87	21	20.5	20	19.8	19.95	18.97	20.15	21.25
5	21.5	21.65	21.5	21	21.25	21	22	22.5	22.2	21.8	21.5	21.84	21.45	20.85	22.32	22.1
8	22.4	22.8	22.15	22.5	22.8	22.6	23.2	24	23.5	22.4	22	22.15	22.82	22.5	23	23.2

Table E9 : Fruit No. /100gm fruit wieght of Cherry Tomato plant under different salinity levels and different treatments

salinity	Fruit no. /100gm (Fruit weight)															
	Soil Type.1			Soil Type.2			Soil Type.3			soil Type.4						soil Type.4
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	5.9	7.26	5.86	6.4	7.56	6.13	7.9	8.66	7.75	6.3	7.07	5.3	6.03	6.6	6.6	5.46
1	6.56	6.8	6.43	6.46	6.1	6.86	6.6	7	6.03	6.4	5.9	6.3	6.66	6.7	6.65	6
3	9.9	11	9.6	9.9	11.2	9.86	11.5	12.56	11	10.5	10	10.8	11.9	10.1	10.7	9.5
5	13.1	13.6	12.9	13.6	14.1	12.7	14	14.46	13.2	12.5	12.66	13.4	14	13	13.3	12.5
8	15.5	16.5	15.5	15.4	16.46	15.7	16.56	17.8	16	15.77	16.36	16.2	17.2	16	16.4	15.2

Table E10 : Plant length of Cherry Tomato plant under different salinity levels and different treatments

salinity	Fruit no. /100gm (Fruit weight)															
	Soil Type.1			Soil Type.2			Soil Type.3			soil Type. 1						soil Type.1
	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	Irr. Water 1	Irr. Water 2	Irr. Water 3	N2	N3	P2	P3	K2	K3	Mulch cover
0	282	274.3	279	271	284	288	265.3	266.7	274.6	282.3	278.6	283	277	279	279.6	298
1	259	249	259	248	233.6	257	243.3	223.3	252	272.6	270	279	258.3	259.3	270.3	281
3	225	213.3	226	218.66	199.6	221.3	234	205	217.3	232.3	232.3	229	221.66	220.3	221.6	239.6
5	175.6	180	190	185	167	174	183.3	168	175.5	184	184.6	187	191.66	188	183.3	204.3
8	173	160.3	176.6	174.3	160	161.6	174	156.6	171.66	170.6	176	172.6	178.6	174	170.6	195

8. ملخص بالعربيه

تأثير الري بالمياه المالحه على البندوره الكرزيه

اعداد

بثينه عبدالله محمود خضر

المشرف

د. مروان حداد

خلال الموسم الزراعي للعام 1998/ 1999 تم زراعة نبات البندوره الكرزيه تحت ظـــروف البيت البلاستيكي في أوعيه . تم القيام بالتجربه في جامعة النجاح الوطنيه / كليه الزراعـــه - محافظة طولكرم. تم القيام بهذه التجربه بهدف دراسة تأثير الري بالمياه المالحه على الانتاجيـه والنوعيه لمحصول البندوره الكرزيه.

تم استخدام مستويات مختلفه من الملوحه لدراسة تأثير الملوحه على البندوره الكرزيـــه ، بما أن النباتات تم زراعتها في أوعيه فان اضافة الاملاح تم اضافتها على شـــكل وزن الملـــح

(Nacl) لكل وحدة وزن تربه، وهذه الاضافه كانت (0 ،1 ، 3 ، 6 و8 غم ملـح لكـل كغـم تربه). كما تم دراسة تأثير مستويات الري المختلفـه (المنخفـض ، المتوسـط ، العـالي) بالاضافه لذلك تم دراسة تأثير ثلاثة أنواع من التربه. تأثير مسـتويات التسـميد المختلفـه (N-P-K) وتأثير غطاء التربه (الملش) أيضا تم دراستها وتأثيرها على زيادة مقاومة النبـات لتأثير الملوحه.

** تم ايجاد ما يلي خلال هذه التجربه:

- كلما زادت الملوحه فان انخفاضا بالانتاج تم ملاحظته في كل المعاملات.
- بينما تم ملاحظة أنه في المعامله التي تم استخدام الملش فيه مع استخدام تربـه طينيـه للزراعه ،وتسميد معتدل (N1-P1-K1) مع مستوى متوسط من الري كان الانخفاض فـي الانتاج في هذه المعامله أقل من بقية المعاملات الاخرى حيث كانت النقطـه التـي يبـدأ الانتاج عندها بالانخفاض نتيجه لتأثره بالملوحه من بيـن أعلـى الارقـام فـي مختلـف المعاملات وهي ($a = 4.5$) كما أن نسبة الانخفاض في النتاج لكل وحدة ملوحـه هـي (slop = 58.4%).
- كما أنه في حالة زيادة التسميد البوتاسي والفسفوري لوحظ زيادة مقاومة النبات لتـأثير الملوحه من حيث أن الانخفاض في الانتاج كان أقل من بقية المعاملات المختلفه.

- من حيث تأثير الملوحه على النوعيه لوحظ تحسن كبير في مقاييس النوعيه للثمار عند زيادة الملوحه وهذه المقاييس هي نسبة المواد الذائبه (TSS) نسبة الســكريات المختزلــه (Reducing Sugar) , نسبة فيتامين C وكمية الاحماض المعادله (Titrable Acid)

- بالاضافة لتأثير الملوحه فان تقليل كمية الري كما في حالة الترب الرمليـــه والتــي لا تحتفظ بالماء فان تعرض النبات للأجهاد يزيد وهذا يزيد من نوعية الثمار.

- كما لوحظ أن pH لعصير الثمار لم يختلف مـــع اختــلاف الملوحــه والمعــاملات المختلفه.