RESULTS AND DISCUSSION

Results obtained will be discussed under three main parts. The first, concerns the effect of chemical stabilizer treatments (bitumen emulsion and polyvinyl acetate) and plant species (*Acacia* and *Leucaena*) and their interaction on germination and germination characteristics in the greenhouse experiment.

The second one deals with the comparison between the two plant species under the soil and production chemical stabilizer treatments on growth characters.

The third, discusses the effect of the two plant species and soil chemical stabilizer treatments as well as their interaction on the degree of aggregation and stability of the soil of sandy dune.

1. Pot experiment

A pot experiment was conducted to study the germination characters of *Acacia saligna* and *Leucaena leucocephala* under several chemical stabilizer treatments (bitumen, polyvinyl acetate and their concentration rates).

I. Germination percentage :

a. Effect of plant species :

Data presented in Table (4) show the changes in germination percentage of *Acacia* and *Leucaena* after 1,2 and 3 weeks after sowing.

There was an increase in germination percentage of *Leucaena* than *Acacia* species 59.78%, 36.25% and 20.55% during the first, second and third weeks after sowing .

These trends were true and reached the 5% level of significance as shown in Table (4).

Apparently ,germination percentage increased with the advancement of germination periods till three weeks after sowing.

Differences in germination percentage during the three weeks after sowing between the two species may be due to the variation in genetic effect between *Leucaena* and *Acacia* besides the thickness of seed coat of *Acacia* which it treated with sulphuric acid to overcome its thickness .

Similar reports were obtained by **Kirmes and Fisher (1989).**

b. Effect of chemical stabilizer treatments :

Results in Table (5) show the effect of chemical stabilizer treatments i.e. bitumen as well as polyvinyl acetate and its concentrations on germination percentage after 1,2 and 3 weeks from sowing.

Germination percentage differed significantly as chemical stabilizer concentrations increased. This trend was fairly true at all germination counts.

Germination percentages increased with bitumen addition after 1,2 and 3 weeks from sowing as compared with the control. On the other hand, germination percentage increased by the addition of polyvinyl acetate in the first week after sowing while this effect tended to decrease as compared with the control in the second and third weeks.

The results indicate clearly that the addition of bitumen emulsion at concentrations of 2.0%, 1.5% and 1.0% scored the highest germination percentages after one, two and three weeks from sowing. These increments were 98.02%, 6.49% and 24.4 % , respectively as compared with the control treatment (without addition).

The superiority of bitumen emulsion as a chemical stabilizer treatments on germination percentage may be due to the role of bitumen emulsion in water catchments because of its crust layer formation on the soil surface which retains more available water for seed imbibitions and germination.

Sharma and Gupta (1999), found that polymers had a significant effect on improving soil structure, crusting behavior of soil, chemical properties, and evaporation losses, eventually improving germination percent.

c. Effect of interaction between plant species and chemical treatments :

Data presented in Table (6) shows the effect of interaction between plant species and soil chemical treatments on germination percentage after one, two and three weeks from sowing.

Leucaena plants was shown to surpassed *Acacia* one in the germination percentage .These was true under the different soil conditioners used i.e bitumen and polyvinyl acetate at the different concentrations used of both as well as at 1,2 and 3 weeks after sowing. Highest germination percentage obtained was under 2.0% bitumen; 1.5% bitumen as well as 1.0% polyvinyl acetate and 1.0% polyvinyl acetate; at 1,2 and 3 weeks after sowing, respectively.

This indicates superiority of *Leucaena* species as well as the soil conditioners used in increasing germination percentage but the rate of superiority was differ at the different rates used which mainly was at 1.5 and 2.0% bitumen and 1.0% polyvinyl acetate . This may be due to the genetic effect which could interact well under the above mentioned concentrations of the soil conditioners.

II . Germination characteristics :

Effect of plant species :

Data in Table (7) shows the effect of the studied plant species i.e. *Leucaena* and *Acacia* on the different germination characters determined at 3 weeks of sowing.

It was appeared the *Leucaena* plant species an overcame *Acacia* one in germination speed, germination capacity, plumule , radical and seedling dry weight. The rate of increase was 42.325%, 32.67%, 111.07%, 49.02% and 82.15 %, respectively. These results indicates the superiority of *Leucaena* plant species than *Acacia* one in the above mentionad germination characters. This may be due to the genetic effect which controlled on germination of seeds and dry weight of radical, plumule and seedling. Similar results were concluded by **Machado and Nunez,19994** for germination speed, **Swamirath 1988 and Omari,1994** for radical, plumule and seedling dry weight.Difference in seedling length between the two studied species was shown as in significant at 5% of significantly . These indicates that seedling elonigation in both species was not effected by gene action. Similar results was obtained by **Bahuguna and Lal (1989), Awadala (1991) Singh *et al* (1989) and Omari (1994).**

Effect of soil chemical stabilizer treatments :

Table (8) shows the response of germination characters to the used soil conditioners at the different concentrations of both.

In general, using both of bitumen and polyvinyl acetate concentration caused an increase in the studied germination characters as compared with no addition.

Increasing bitumen concentration was up 2.0% shown to increase the studied germination characters with vice versa trend was obtained four polyvinyl acetate concentration mainly

in germination speed, germination capacity and radical dry weight. Highest germination characters was obtained in bitumen soil conditioners at 2.0%, 2.0%, 2.0%,2.0%,1.5% and 1.5% concentrations four germination speed, germination capacity, seedling length, radical and seedling dry weight, respectively. For plumule dry weight, it was highest at 0.5% polyvinyl acetate concentration**.** These results were in agreement with those obtained by **Awad *et al* (1988)** who found increases in germination of broad bean after 15 days from bitumen or/ and polyacrylamide application.

c. Effect of interaction between plant species and chemical stabilizer treatments :

Data in Table (9) shows the effect of interaction between plant species (*Acacia saligna* and *Leucaena leucocephala*) and soil chemical stabilizer treatments (bitumen emulsion at 3 concentrations i,e. 1.0%, 1.5% and 2.0% as well as polyvinyl acetate at 3 concentrations i.e. 0.5%, 1.0% and 1.5% and the control treatment on germination characteristics (germination speed, germination capacity, plumule dry weight, radical dry weight, seedling dry weight and seedling length).

The interaction between plant species and both two soils conditioners and their concentrations induced different responses for the studied growth the germination characters.

Highest germination speed, radical and seedling dry weight were obtained when used bitumen soil conditioners.

This was at the concentrations of 2.0%,1.5% and 1.5%, in respect. It could be concluded that application of bitumen at rates of 1.5% to 2.0% accelerate the germination producing weigher radical and seedling. This was true in *Leucaena* plant species comparable with *Acacia* one .

Similar trend was obtained by **Machado and Nunez,19994** for germination speed and **Awad *et al* (1983b), Matyn *et al* (1988), Abd El-Fattah *et al* (1990), El-Hady *et al* (1991) and Ahmed (1995),** for seedling dry weight .

On the other hand, application of polyvinyl acetate induced more germination capacity seedling length and plumule dry weight in comparison with that bitumen application .The highest measurements were obtained at 1.0%,1.5% and 0.5%, respectively for the above mentioned germination characters more than the other concentration of both bitumen, polyvinyl acetate and no addition of soil conditioners. This was true under *Leucaena* plant species compared with *Acacia* one . It could be concluded that both of bitumen and polyvinyl acetate at the different concentrations acts together on the germination characters with different rates for every character .

Similar trends were obtained by **Bahuguna and Lal (1989), Awadala (1991) Singh *et al* (1989) and Omari (1994).**

II. Field experiment

The field experiment was carried out to investigate the effect of bitumen at concentration s at 1.0%,1.5%,2.0%and 2.5%, polyvinyl acetate at 0.5%,1.0%,1.5% and 2.0 % compared with no addition on the growth characters of *Leucaena* and *Acacia* at 3,6 and 9 months after planting. The following is the results obtained under the effect of soil chemical stabilizer, plant species and their interaction.

1. Plant height :

a. Effect of chemical stabilizer treatments :

Data presented in Table (10) indicates the effect of chemical stabilizer treatments as soil conditioners i.e. bitumen and polyvinyl acetate and its concentrations on plant height at 3, 6 and 9 months after planting. It was clear that chemical stabilizer treatments had significant effects on plant height during the three studied ages of growth.

Generally, with increasing the concentrations of chemical treatments, plant height increased during the three stages of growth.

With regard to, the soil conditioners concentrations, it was apparent that concentrations of 2.0% of bitumen at 3 months of applications was the best for producing taller plants (34.08 cm); whilst at 6 and 9 months taller plants were produced by 2.5% and 2.0% of bitumen and polyvinyl acetate, respectively. This indicates that applying soil conditioners induced more plant elongation whatever at 3,6 or 9 months of planting. This was true under higher rate of both soil conditioners, mainly 2.0% and/or 3.5%.

This may be due to the effect of soil conditioners in inducing more soil stability in caused more water retention in soil which is helpful in more growth rate and extension. These results were in agreement with those obtained by **Abd El-Fattah *et al* (1990)**, who indicate the effect of bitumen in absorbing solar radiation rapidly due to its black colour and then longer moisture retaining in the soil .

b. Effect of plant species :

Data in Table (11) indicate the plant height response of *Acacia* and *Leucaena* species at stages of 3, 6 and 9 months from planting.

Leucaena plants appeared more elongation than those of *Acacia* one. This response was true and enough to reach the 5% level of significance after 3 and 9 months from planting. On the other hand, plant height of the two studied species increased with the advancement of plant age.

Table (11): Effect of plant species on plant height (cm) after 3, 6 and 9 months from planting.

Plant species	Plant height (cm)
	3 months from planting
Acacia	16.96
Leucaena	19.54
L.S.D. at 0.05	1.47
	6 months from planting
Acacia	45.22
Leucaena	39.50
L.S.D. at 0.05	4.51
	9 months from planting
Acacia	53.15
Leucaena	54.67
L.S.D. at 0.05	N.S.

Also, *Leucaena* species were surpassed of the control one (without application) during the first stage by 15.2% while these effect changed in the second and third stages by 14.48% and 2.86% by planting *Acacia* than *Leucaena*.

The superiority of *Leucaena* than that of *Acacia* may be due to the genetic effect since *Leucaena* had the ability to use the environmental conditions well to produce more plant cells and elongation as compared with that of *Acacia* species.

Similar trends were obtained by **Singh *et al* (1989), Kamis *et al* (1993) and Abdel Rauf *et al* (2003)** who found differences in plant height owing to genetic effects between different plant species.

c. Effect of the interaction between plant species and chemical stabilizer treatments :

Data presented in Table (12) show the response of plant height of the two studied species to chemical stabilizer treatments after 3, 6 and 9 months from application.

It was appear that cultivation of *Acacia* and *Leucaena* species under chemical stabilizing treatments tended to induce more plant elongation.

It could be concluded that plant height of *Acacia* or *Leucaena* planted under the application of chemical soil conditioners (bitumen and polyvinyl acetate with its concentrations) increased significantly at 3, 6 and 9 months after application. Applying 2.0% polyvinyl acetate to the soil planted with *Leucaena* produced the highest plants (91.0 cm).

This may be due to the effect of soil conditioners on soil stability as well as the increase in water catchments in which could be helpful in more growth and elongation .Some workers came to the same trend as **Abd El Fattah *et al* (1990).**

2. Number of leaves/plant :

a. Effect of chemical stabilizer treatments :

As shown in Table (13), number of leaves/plant was significantly affected by using chemical stabilizer treatments and their concentrations. The obtained results indicate that adding 2.0% polyvinyl acetate scored the highest number of leaves/plant under any plant age investigated.

Under the treatment of adding 2.0% polyvinyl acetate, number of leaves/plant increased by 36.90%, 126.78% and 350% as compared with those of the control at 3, 6 and 9 months after application, respectively. Chemical treatment of polyvinyl acetate was shown to induce more leaves formation as compared with that of bitumen one. This may be due to the mode of action of polyvinyl acetate as compared with the bitumen since it acts as a chelating agent catching more nutrients as well as water. This in turn could enhance the leaves production compared with that of bitumen which affects the soil stability and more water retention in soil. These results are in agreement with those obtained by **Sharma and Gupta (1999) and Abdel Rouf *et al*. (2003).**

b. Effect of plant species :

Data presented in Table (14) shows the differences in number of leaves/plant between the two studied species.

Leucaena species surpassed *Acacia* in number of leaves/plant at the three plant ages i.e. 3,6 and 9 months after planting and these increments were 90.57%, 235.37% and 106.32% at the three previous mentioned ages.

Table (14): Effect of plant species on number of leaves/plant after 3, 6 and 9 months from planting.

Plant species	Number of leaves /plant
	3 months from planting
Acacia	14.63
Leucaena	27.88
L.S.D. at 0.05	0.94
	6 months from planting
Acacia	26.24
Leucaena	88.00
L.S.D. at 0.05	8.78
	9 months from planting
Acacia	38.29
Leucaena	79.00
L.S.D. at 0.05	3.17

It was apparent that the superiority of *Leucaena* species in number of leaves/plant was significant and increased as plant age increased.

This may be due to the gene action which affect on the leaves production in which it is valuable in *Leucaena* comparable with in *Acacia* one.

c. Effect of the interaction between plant species and chemical stabilizer treatment :

Data in Table (15) show the interaction effect between plant species and soil chemical stabilizer treatments at 3, 6 and 9 months after application.

Number of leaves/plant was influenced significantly by the interaction between plant species and chemical treatments. This effect was true at 3, 6 and 9 months after plating.

Applying chemical stabilizer treatments (bitumen and polyvinyl acetate and concentrations) influenced number of leaves/plant. Adding 1.0% polyvinyl acetate produced more leaves (33.57 leaves/plant) for *Leucaena* plant at 3 months after application, whilst after 6 and 9 months, adding 2.0% polyvinyl acetate with cultivation *Leucaena* gave the highest numbers of leaves/plant (174.75 and 185.00) as compared with the control.

This may be due to the combined effect of soil conditioners as chemical way for sand stabilization and plant species as biological sand stabilizer on soil stability or/and water as well as mineral retention in soil which induce more leaves production.

3. Stem diameter :

a. Effect of chemical stabilizer treatments :

Data tabulated in Table (16) show the effect of soil chemical stabilizer treatments on stem diameter after 3, 6 and 9 months from application.

Due to the chemical stabilizer effect, there were significant differences in stem diameter at all the studied growth stages.

The effective concentration which play an important role to maximize stem diameter changed according to plant growth stage, it was 2.5% bitumen at 3 and 6 months stages (37.50 and 62.50 mm) respectively while it was 1.5% of polyvinyl acetate for the growth age of 9 month from application which gave the thickest stem diameter (95.50 mm). The values of the increments were 25%, 32.61% and 24.03% as compared with control treatment at 3, 6 and 9 months after planting, respectively.

This may be due to the effect of chemical treatments i.e. bitumen and polyvinyl acetate on soil stabilization and water retention which could induce more growth rate resulted in that stem widening as a phenomena of growth. Similar reports were described by **Pokhriyal *et al* (1997)** since they concluded increases in stem diameter and dry weight of leaves of Acacia by polymers application .

b. Effect of plant species :

The differences of stem diameter between *Acacia* and *Leucaena* plant species after 3, 6 and 9 months from planting shown in Table (17).

It is noticed that the increase in the stem diameter of *Acacia* species was more than that in *Leucaena* during the studied growth stages i.e. 3, 6 and 9 months from planting.

The increase was so great and enough to reach the level of significance.

Also, stem diameter of *Acacia* surpassed those of *Leucaena* plants at all the growth stage by (19.15%, 50.98% and 114.69% after 3, 6 and 9 months from planting).

Table (17): Effect of plant species on stem diameter (mm) after 3, 6 and 9 months from planting.

Plant species	Months from planting
	3 months from planting
Acacia	32.92
Leucaena	27.63
L.S.D. at 0.05	3.70
	6 months from planting
Acacia	60.92
Leucaena	40.35
L.S.D. at 0.05	17.88
	9 months from planting
Acacia	111.33
Leucaena	51.79
L.S.D. at 0.05	15.78

These results may be due to the genetic variation between the two plant species under study.

Similar results were reported by **Bahuguna and Lal (1989).**

c. Effect of the interaction between plant species and soil chemical stabilizer treatments:

The results in Table (18) show the response of stem diameter of *Acacia* and *Leucaena* plant species at different concentrations of chemical stabilizer treatments i.e. bitumen and polyvinyl acetate and their concentrations after 3, 6 and 9 months from planting. Soil treated with 2.5% bitumen and planted with *Acacia* surpassed other treatments at 3 and 6 months after application, whilst at 9 months from application adding 2.0% polyvinyl acetate and planted with *Acacia* scored the best results (141.00 mm) as shown in Table (18).

It could be concluded that *Acacia* species surpassed *Leucaena* one; as well as adding soil conditioners at different rates increased stem widinning at 3,6 and 9 months age, but the highest increase was at concentrations of 2.5% bitumen and 2.0% polyvinyl acetate at plant ages studied.

These results in stem widening may be owing to the effect of chemical treatments as soil conditioners (bitumen and polyvinyl acetate) on more soil stability and consequently water retention which could resulted in more stem extension as a phenomena of the two studied species and manifested in plant growth.

4. Dry weight/plant :

a. Effect of soil chemical stabilizer treatment :

Results tabulated in Table (19) show the effect of chemical stabilizer treatments on plant dry weight of the two studies species at 3, 6 and 9 months after application.

It is clear that a significant increase in dry matter production was produced by applying chemical stabilizer treatments for all the studied periods after application. This may be due to the effect on the sand dune stability as well as more water retention. This resultant could be expected with more photosynthetic activity as well as the expansion of root system.

With regard to the effect of chemical stabilizing treatments, it is clear that when applying bitumen with the concentration of 2.5%, higher dry matter production was obtained (11.66 and 42.65 g), after 3 and 6 months from application, while at 9 months from planting, the best dry matter/plant (74.63 g) resulted from adding 2.0% bitumen as shown in Table (19).

This may be due to the effect of both soil conditioners on soil stability and soil water retention and their effect on more growth rate expected resulted in more dry matter production. Also, for polyvinyl acetate as chemical stabilizer which acts as chelating agent for water and minerals and their availability whilst bitumen acts as a highly viscose material blocked the soil surface and prevent returned water in soil to evaporation. This water increased in availability to absorb by root system towards aging due to its spreading in soil. Similar reports obtained by **Matyn *et al* (1988).**

b. Effect of plant species :

Results in Table (20) show the response of plant dry weight to plant species (*Acacia* and *Leucaena*) at 3, 6 and 9 months after application.

Dry matter production of *Acacia saligna* species was surpassed that of *Leucaena leucocephala* after 3 and 9 months from planting (8.09 and 46.75 g, respectively)

whilst after 6 months the *Leucaena* dry matter production was the best (30.37g).

Table (20): Effect of plant species on plant dry weight (g) after 3, 6 and 9 months from planting.

Plant species	Months from planting
	Plant dry weight (g)
	3 months from planting
Acacia	8.09
Leucaena	4.61
L.S.D. at 0.05	2.94
	6 months from planting
Acacia	26.35
Leucaena	30.37
L.S.D. at 0.05	3.02
	9 months from planting
Acacia	46.75
Leucaena	41.09
L.S.D. at 0.05	4.62

This trend may be due to the gene effect on increasing more root extension which could result in more water and mineral absorption and consequently more growth rate resulted in more dry matter production.

Similar results were obtained by **Awadala (1991) and Stewart *et al* (1993).**

Effect of the interaction between plant species and soil chemical stabilizer treatments:

The obtained results in Table (21) show the response of plant dry weight to the interaction between plant species i.e. *Acacia* and *Leucaena* and chemical stabilizer after 3,6 and 9 months from planting.

The response was fairly true and reached the 5% level of significance. Applying 2.0% polyvinyl acetate to the soil planted by *Acacia* scored the highest plant dry weight (16.53 g) as compared with the control treatments at 3 months after application.

After 6 and 9 months from application, *Leucaena* grown in sandy soil covered with 2.5% bitumen produced the highest plant dry weight as compared with the control .

Similar trends were observed by **Draz *et al* (1996).**

III. Soil stability :

a. Effect of chemical stabilizer treatments on soil mechanical analysis :

Data in Table (22) show the effect of the studied soil chemical stabilizing treatments on the soil fraction at 6 and 9 months after application as compared with the control before planting.

In general, it was a trend of a decrease or increase in the different soil fractions i.e. very coarse, coarse, medium, fine and very fine in relation to the different concentrations of bitumen and polyvinyl acetate. This was true and significant at 6 or 9 months of applications.

Table (22) : Effect of soil chemical stabilizer treatments on the soil mechanical analysis of the field experimental soil at 6 and 9 months from application.

Soil chemical treatments	Soil constituents				
	Very coarse 2.00 mm	Coarse 1.00 mm	Medium 0.50 mm	Fine 0.25 mm	Very fine 0.125 mm
Control	0.30	1.91	40.05	53.52	4.22
	After 6 months from planting				
Control	0.68	0.14	0.26	60.47	38.45
Bit 1.0%	0.30	0.18	0.39	65.67	33.46
Bit 1.5%	0.19	0.18	1.59	65.67	32.37
Bit 2.0%	0.27	0.18	0.35	55.42	43.78
Bit 2.5%	0.34	0.28	0.57	58.99	39.85
PVC 0.5%	0.42	0.22	0.37	64.68	34.31
PVC 1.0%	0.29	0.22	0.48	67.87	31.14
PVC 1.5%	0.43	0.31	0.49	62.55	36.22
PVC 2.0%	0.63	0.34	0.46	67.54	31.03
L.S.D. at 0.05	0.04	0.003	0.14	3.64	13.40
	After 9 months from planting				
Control	0.12	0.15	0.27	58.54	40.92
Bit 1.0%	0.18	0.12	0.42	75.77	23.51
Bit 1.5%	0.27	0.31	0.26	62.88	36.28
Bit 2.0%	0.30	0.20	0.36	63.46	35.68
Bit 2.5%	0.16	0.17	0.33	71.03	28.31
PVC 0.5%	0.18	0.21	0.48	68.73	30.40
PVC 1.0%	0.35	0.19	0.65	64.59	34.22
PVC 1.5%	0.25	0.25	0.43	62.80	36.27
PVC 2.0%	0.18	0.38	0.50	68.57	30.37`
L.S.D. at 0.05	0.17	0.12	0.08	2.62	2.77

Bit : Bitumen
PVC : Polyvinyl acetate

The untreated soil with soil conditioners was shown to increase in very coarse particles at 6 months and vice versa at 9 months from planting. Coarse and medium particles appeared a decrease at 6 and 9 months whilst that of the fine and very fine sand particles shows an increase. This indicates that planting this soil induced a great change in the sand particles constituemts due to the time of 6 and 9 months after planting.

As the soil conditioners used at different rates, the soil particles showed a great response. Coarse and medium particles were decreased and vice versa was obtained for fine and very fine particles .This was true under both of bitumen and polyvinyl acetate at the different concentrations used at 6 or 9 months after planting very coarse particles showed fluctuation trend, but seems to increase under polyvinyl acetate rates mainly at 2.0% at 6 months after planting, whilst at 9 months plant age it was an opposite trend.

It could be concluded that using soil conditioners i.e. bitumen and polyvinyl acetate with the mentioned rates caused an increase in the small soil particles i.e. fine and very fine sand whilst coarse and medium one were decreased.

Similar trend was obtained by **Vandevelde *et al* (1974), Pla (1975), Wahkba (1980), El-Hady (1984), El-Amir (1987), Diab *et al* (1988), Salem (1988), El Hady and Hanna (1989) and Ahmed (1995).**

It could be concluded that after 6 months from application, with increasing bitumen emulsion concentrations very coarse particle decreased until 1.5% and then its increased. On the other hand, significant increases in very coarse particle appeared as polyvinyl acetate rate increased as shown in Table (22). These changes in very coarse particles were true and reached the 5% level of significance..

Coarse particles changed significantly as affected by chemical stabilizer treatments. The obtained values of coarse particles were Lesser than their counterparts of the control (1.91), but generally, with increasing the concentrations of bitumen emulsion or/and polyvinyl acetate, coarse particles aggregation increased at 6 months from application.

Medium particles increased significantly with increasing bitumen emulsion as well as polyvinyl acetate rates.

Applying 1.5% bitumen caused the highest value of medium particle after 6 months from planting.

At 6 months after application, fine particles scored significant increases than control treatment (53.52). Applying 2.0% polyvinyl acetate scored the highest fine aggregate value (67.87) as compared with the control (before application). The rate of increased was (26.81%) higher.

Very fine particles changed significantly with the application of chemical stabilizer treatments either bitumen or polyvinyl acetate. Formation of very fine aggregates was higher than control one (4.22). It could be concluded that, after 6 months from application, chemical stabilizer treatments tend to form higher aggregates as its concentrations increased. Bitumen emulsion rates (2.0%)

scored the highest formation of very fine constituent as shown in Table (2). This increments was (90.36%) than control treatment (4.22)

After 9 months from application, very coarse increased significantly with increasing most of the concentration of chemical stabilizer treatments as shown in Table (22). With the application of 1.0% polyvinyl acetate, very coarse particle was the highest value and reached 14.28% more than control one (0.30).

Coarse particle formation after 9 months from was Lasser than control one although the values changed significantly as affected by chemical stabilizer treatments.

Significant changes were observed in medium particles as influenced by the concentration of chemical stabilizer treatments under study (Table 22). The values of medium particles were Lasser than the control (before planting) and the lowest value (0.26) was obtained with the application rate of 1.5% bitumen.

Formation of fine aggregation particles, higher than control and reached the 5% level of significance after 9 months from application. Applying 1.0% bitumen emulsion caused the highest percentage of fine particle formation. The increment reached (41.57%) than control treatment

Significant increases were obtained in very fine particles as influenced by chemical stabilizer treatments as compared with control after 9 months from applying.

Generally, it could be concluded that fine and very fine particles tended to aggregate with increasing the concentrations of chemical stabilizer treatments. These criteria was true either after 6 or 9 months from application. The main conclusion from the previous data could be reported that its useful to use bitumen emulsion or/and polyvinyl acetate to change the smaller sand particles to bigger one and that effect minimize sand dune movement.

Similar results were obtained by many investigators as: **Vandevelde *et al* (1974), Pla (1975), Wahkba (1980), El-Hady (1984), El-Amir (1987), Diab *et al* (1988), Salem (1988), El Hady and Hanna (1989) and Ahmed (1995).**

b. Effect of plant species on soil mechanical analysis :

Using *Leucaena* and *Acacia* plant species as a biological factor for sand dune fixation appeared in Table (23). Results obtained shows that biological effect induced remarkable effect on the soil particle fractions. This was true at 6 and 9 months of cultivation. It was a trend similar to that of using chemical factor mentioned previously . An increase in the small particles i.e. fine and very fine sand particles while opposite was for the coarse and medium one, at both 6 and 9 months after planting. Similar trend in general was for very coarse soil particles at 6 months and for *Leucaena* only at 9 months after planting.

According to the plant species used; *Acacia* was shown to surpassed *Acacia* one in that effect except very fine sand particles. This was true at 6 and 9 months of planting. 0

It could be concluded that using plant species in sand fixation considered as valuable increasing fine and very fine particles as well as very coarse one while the opposite was ror the coarse and medium particles. Highest rate was obtained under using *Acacia* plant species. Similar trend was obtained by **Draz *et al* (1996)** and **Abdel Rauf *et al* (2003).**

c. Effect of the interaction between chemical treatments and plant species on soil mechanical analysis :

Table (24) shows the interaction effect between chemical stabilizer treatments and plant species on the soil fractions of sand dunes after 6 and 9 months of planting as compared with control (before planting). It was apparent

that a significant increase or decreased in the soil particles due to the application of whatever plant species or soil conditioners at different rates.

Data of very coarse particles shows fluctuated trend; it was increased or decreased upon the both studied factors. Highest amounts were obtained at o.5% polyvinyl acetate and 1.5 % as well as 2.0% bitumen than measured 6 and 9 months after planting, respectively in *Leucaena* species. Lesser amounts were determined at other rates of both soil conditioners either under *Leucaena* or *Acacia* one .

Coarse and medium soil particles appears a clear trend of decrease than the control before planting as using different rates of soil conditioners as well as the plant species. Highest decrease was obtained at 1.0% polyvinyl acetate and 1,0% bitumen after 6 and 9 months after planting for coarse particles; 2.0% bitumen and 1.0% polyvinyl acetate for medium particles at 6 and 9 months for *Leucaena* and *Acacia* species respectively . Opposite trend was obtained for fine and very fine particles since there was an increase in their amounts under the use 0of both soil conditioners and plant species. The highest increase for the fine particles was at 1.5% and 1.0% bitumen in *Leucaena* and *Acacia* at 6 and 9 months after planting, respectively; whilst for the very fine particles it was at 2.0% bitumen and 1.5% polyvinyl acetate under *Acacia* species at 6 and 9 months, respectively **Roy and Chatterjee (1971) and Awad (1983a). O**r decrease in the different types of soil fractions due to the effect of the interactions.

Very coarse soil fraction was shown to be affected by the interaction between plant species and chemical stabilizer treatments. The highest value of very coarse particles was obtained with the application of 1.5% bitumen to soil planted with *Acacia* after 9 months from planting (0.48) while at 6 months from planting, applying 2.0% polyvinyl

acetate caused the highest value (0.81) for very coarse particles with soil planted with *Leucaena*.

Coarse fraction changed significantly as affected by the effect of interaction between the two studied plant species and chemical stabilizer treatments as shown in Table (24).

After 6 months from planting, *Leucaena* scored the highest coarse value (0.72) although it was lesser than control value (1.91).

After 9 months from planting, the lowest value of coarse aggregation (0.05) was obtained by adding 1.0% bitumen emulsion and planting *Leucaena*.

Medium particles influenced significantly by the interaction between plant species X chemical stabilizer treatments after 6 and 9 months from planting (Table 25).

After 6 months from planting the highest (2.96) and lowest (0.04) values with the application of 1.5% and 2.0% of bitumen emulsion to soil planted with *Leucaena*.

After 9 months form planting, adding 1.0% polyvinyl acetate scored the lowest and highest values (0.20 and 1.10) in soil grown planted with *Acacia* and *Leucaena* plants, respectively.

Fine particles affected significantly with the interaction between plant species and chemical stabilizer treatments.

After 6 months from planting, adding 1.5% bitumen emulsion caused the highest rate of fine particles under planting *Leucaena* (77.46), whereas the lowest value (52.91) was recorded with *Acacia* treated by adding 2.0% bitumen emulsion.

After 9 months from planting growing *Acacia* in soil treated with 1.0% bitumen emulsion and gave the highest

value (77.80) and the lowest value (57.46) obtained from 1.5 polyvinyl acetate.

Very fine particles changed under the interaction between plant species and chemical stabilizer treatments and these effects reached the 5% level of significances.

After 6 months, soil treated by 2.0% bitumen emulsion and grown with *Acacia* gave the highest value of very fine particles (46.40), while soil treated by 1.0% bitumen emulsion and grown with *Leucaena* gave the lowest value (26.59) of very fine particles as compared with the control (4.22).

At 9 months soil treated by 1.5% polyvinyl acetate and planted by *Acacia* caused the highest value (41.73) of very fine particles. On the other hand, applying 1.0% bitumen emulsion gave the lowest value of very fine particles (21.31) with growing *Acacia* after 9 months from application.

Some workers came to the same trend as **Roy and Chatterjee (1971) and Awad (1983a).**