RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

The present dissertation represents a general survey of the interaction between mineral and biofertilizers on growth, yield and biocontents of some economic crops.

The numerous results obtained during the course of the present work necessitated the presentation of data under two parts.

Every part include several headings which were in turn subdivided into various subheadings to cover the various aspects related to the main title and undoubtedly such a system proved very practical where simplicity and clarity is the major consideration.

The main titles are:

Part I:

4.1.1. Effect of bio and mineral fertilizers on growth parameters of wheat plant

4.1.2. Effect of bio and mineral fertilizers on N, P and K concentration and uptake by wheat plant.

4.1.3. Chemical composition of wheat grains.

4.1.4. Follow-up of contents of total nitrogen and available P and K of the wheat cultivated soil due to fertilization.

Part II:

4.2.1. Effect of bio and mineral fertilizers on growth parameters of soybean plant.

4.2.2. Effect of bio and mineral fertilizers on N, P and K concentration and uptake by soybean plant.

4.2.3. Chemical composition of soybean seeds.

4.2.3.1. Separation and identification of the fatty acids composition of soy bean oil.

4.2.3.2. SDS-PAGE patterns of soybean proteins

4.2.4. Follow-up of total nitrogen and available P and K of the soybean cultivated soil due to fertilization.

Part I:

4.1. Growth parameters and N, P and K uptake of wheat plants:
4.1.1. Effect of biofertilizers and mineral fertilizers on growth parameters of wheat plant:

The effect of mineral nitrogen fertilizer added to the soils as urea at the recommended rate (75 kg N/Fed) on some growth parameters of wheat plant was compared with that of inoculating the rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** or mixture of ***Azotobacter sp and Azospirillum sp*** or combination between the mineral fertilizers and the bacterial species at different proportions.To fulfil this purpose, eleven fertilization treatments were involved in a field experiment during seasons 1991/1992, in which wheat was grown and the growth parameters were measured after 45, 100 days of cultivation and at the harvesting stage. The same experiment was repeated once again during seasons 1992/1993. The obtained results are given in Tables (3, 4, 5, 6, 7 and 8).

4.1.1.1. Plant height:

Data presented in Tables (3, 4, 5 and 6) reveal in comparison with the control treatment, that the studied fertilization treatments significantly increased plant height whether after 45 or 100 days of cultivation.

Inoculation with *Azotobacter sp* or *Azospirillum sp* alone resulted in plant height much less than that yielded due to fertilization with the recommended rate of the mineral fertilizers. The effect of combination between the mineral fertilizer and inoculation on plant height differed according to their rates of application and the bacterial species. The application of the mineral fertilizer at 75% of its recommended rate with 1/4 the suggested dose of *Azotobacter* or 1/4 *Azospirillum* yielded plant height almost similar or even higher than that yielded upon fertilization with the mineral fertilizer. The other combinations between the mineral nitrogen and the inoculating bacterial produced plants of less height, yet this height still remained for higher than that yielded by the control treatment. Such results agree well with Armanios (1987) in his work on wheat.

It is worthy to indicate that in the absence of the mineral fertilization, inoculation with a mixture of *Azotobacter sp* and *Azospirillum sp* stimulated plant growth and produced plants height almost equivalent to that produced due to fertilization with the field recommended rate of the inorganic nitrogen (urea).

4.1.1.2. Number of tillers:

Data in Tables (3, 4, 5 and 6) reveal that number of tillers was affected significantly by the mineral and biofertilization. The effect of nitrogen fertilization combined with the inoculation of the wheat plants with *Azotobacter sp* or *Azospirillum sp* at different proportions yielded number of tillers relatively lower than that yielded due to application of the field recommended rate of the inorganic nitrogen except for the combination between 75% of the recommended rate of the mineral nitrogen fertilizer and either of *Azotobacter sp* or *Azospirillum sp* where the number of tillers

Table (3) : The interaction effect of bio and mineral fertilizers on plant height number of tillers and dry weight after 45 days from planting wheat 1991/1992 season.

No	Treatment	plant height (cm.)	Number of tillering	Dry weight (g.)
1	Control	28.000	1.75	1.85
2	75 kg N/Fed.	59.250	4.50	8.15
3	Azotobacter 200g/Fed. (A)	49.800	2.75	3.47
4	Azospirillum 200g/Fed. (B)	50.00	2.50	3.62
5	100 A + 100g. B	52.05	3.25	4.72
6	56.25 kg N/Fed+50g A/Fed	59.00	4.25	8.47
7	37.50kg N/Fed+100g A/Fed	54.00	3.00	5.50
8	18.75 kg N/Fed+150g A/Fed	51.75	2.50	4.32
9	56.25 kg N/Fed+50g B/Fed	59.00	5.25	9.17
10	37.50 kg N/Fed+100g B/Fed	54.40	3.00	5.37
11	18.75 kg N/Fed+ 150g B/Fed	50.25	2.50	5.07
	L.S.D 5%	3.69	0.93	0.67

(A) Azotobacter sp. (B) Azospirillum sp.

Table (4) : The interaction effect of bio and mineral fertilizers on plant height in number of tillers and dry weight after 45 days from planting wheat 1992/1993 season.

No	Treatment	plant height (cm.)	Number of tillering	Dry weight (g.)
1	Control	27.00	1.50	1.33
2	75 kg N/Fed.	54.12	5.75	8.35
3	Azotobacter 200g/Fed. (A)	45.87	2.75	2.00
4	Azospirillum 200g/Fed. (B)	46.75	2.25	2.42
5	100 A + 100g. B	47.37	3.00	2.07
6	56.25 kg N/Fed+50g A/Fed	55.87	5.75	8.85
7	37.50kg N/Fed+100g A/Fed	48.87	3.25	5.92
8	18.75 kg N/Fed+150g A/Fed	37.50	2.75	3.35
9	56.25 kg N/Fed+50g B/Fed	57.37	5.25	9.77
10	37.50 kg N/Fed+100g B/Fed	43.62	3.50	6.32
11	18.75 kg N/Fed+ 150g B/Fed	40.25	2.25	3.60
	L.S.D 5%	6.07	0.79	0.50

(A) Azotobacter sp. (B) Azospirillum sp.

Table (5) : The interaction effect of bio and mineral fertilizers on plant height number of tillers and dry weight after 100 days from planting wheat 1991/1992 season.

No	Treatment	plant height (cm.)	Number of tillering	Dry weight (g.)
1	Control	63.22	2.50	3.45
2	75 kg N/Fed.	106.50	7.75	13.60
3	Azotobacter 200g/Fed. (A)	85.97	4.00	7.92
4	Azospirillum 200g/Fed. (B)	80.05	4.50	7.67
5	100 A + 100g. B	105.15	4.30	7.65
6	56.25 kg N/Fed+50g A/Fed	110.22	8.50	13.65
7	37.50kg N/Fed+100g A/Fed	106.72	6.75	8.67
8	18.75 kg N/Fed+150g A/Fed	95.30	5.75	7.87
9	56.25 kg N/Fed+50g B/Fed	112.55	9.00	14.75
10	37.50 kg N/Fed+100g B/Fed	99.77	6.25	8.47
11	18.75 kg N/Fed+ 150g B/Fed	93.70	5.50	6.95
	L.S.D 5%	8.45	1.20	1.55

(A) Azotobacter sp. (B) Azospirillum sp.

Table (6) : The interaction effect of bio and mineral fertilizers on plant height number of tillers and dry weight after 100 days from planting wheat 1992/1993 season.

No	Treatment	plant height (cm.)	Number of tillering	Dry weight (g.)
1	Control	61.00	2.25	3.175
2	75 kg N/Fed.	103.60	8.75	14.10
3	Azotobacter 200g/Fed. (A)	82.50	4.25	6.60
4	Azospirillum 200g/Fed. (B)	71.92	4.35	5.65
5	100 A + 100g. B	82.75	4.00	5.57
6	56.25 kg N/Fed+50g A/Fed	102.67	8.85	15.10
7	37.50kg N/Fed+100g A/Fed	85.40	6.92	6.95
8	18.75 kg N/Fed+150g A/Fed	74.55	4.35	5.20
9	56.25 kg N/Fed+50g B/Fed	107.37	9.77	14.47
10	37.50 kg N/Fed+100g B/Fed	81.65	7.32	9.15
11	18.75 kg N/Fed+ 150g B/Fed	54.62	4.60	5.65
	L.S.D 5%	8.48	0.50	1.52

(A) Azotobacter sp. (B) Azospirillum sp.

produced was markedly higher than that yielded due to application of the recommended rate of the inorganic nitrogen. The results indicate also that the response of number of tillers to inoculation with either of the two bacterial species alone was less than the response to the mineral fertilizer alone.

It is obvious from results that number of tillers per plant after 100 days of cultivation was higher than that recorded after 45 days, however, the relative effects of the different fertilization treatments followed the same direction previously mentioned in both stages of growth. Also, the patterns of response to the fertilization treatments in the first and second seasons were similar.

These results are in agreement with those obtained by Madkour (1972) in his work on wheat.

4.1.1.3. Dry weight:

Dry weight of wheat plant after 45 or 100 days of planting, Tables (3, 4, 5 and 6) seemed to be affected significantly by fertilization with the inorganic nitrogen or the inoculation of the rhizosphere by either ***Azotobacter*, *Azospirillum*** species or both separately or combined with the mineral nitrogen fertilizer. The dry weight is considered to a large extent, a final product of the plant height and the number of tillers per plant. Therefore, the different fertilization treatments showed effects on plant dry weight similar to those previously shown on plant height and number of tillers i.e. the biofertilization through inoculation yielded plant dry weight relatively lower than that yielded due to fertilization by the recommended rate of the inorganic nitrogen only. Also, inoculation of the plant rhizosphere with 50g/ Feddan of either ***Azotobacter sp*** or ***Azospirillum sp*** combined with application of the inorganic nitrogen in three fourths of its recommended rate resulted in dry matter yield slightly higher than that obtained upon fertilization with the recommended rate of the inorganic nitrogen only.

It is worthy to mention that, the dry weight of the plants grown in season 1992/1993 was affected by the studied different fertilization treatments in a way similar to that occurred in the first season of cultivation 1991/1992 although the plant dry weight obtained due to a certain treatment in season 1992/1993 was relatively lower than the corresponding plant dry weight obtained due to the same treatment in season 1991/1992.

The obtained results and the given explanations are in close agreement with many of the previous studies e.g. Badawy and Amer (1974); Ishac ***et al*** (1981); Fayez (1981) and Gohar ***et al*** (1986) in their investigation on wheat.

4.1.1.4. <u>Spike length</u>:

It is clear from data presented in Tables (7and 8) that the spike length of wheat plant at the harvest stage increased significantly due to fertilizing the soil with the inorganic nitrogen at its recommended field rate, inoculation with ***Azotobacter sp*** or ***Azospirillum sp*** or mixture of the two bacterial species or combination between the inorganic nitrogen fertilizer and inoculation of the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** at different proportions.

The recommended rate of the inorganic nitrogen yielded spike length greater than that obtained upon inoculation of the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** alone. It seems that inoculation with application of the inorganic nitrogen resulted in spike length greater than that produced upon inoculation with either of the studied bacterial species. Moreover, the interaction effect between the mineral fertilizer added

Table (7) : The interaction effect of bio and mineral fertilizers on spike length cm, number of spikelets, number of grains per spike, weight of grain per spike g, weight of 1000 grain g, grain yield kg/Fed and straw yield kg/Fed at harvest stage on wheat plant, season 1991/1992

No	Treatment	Spike length cm	No. of spikelets per spike	No. of grain per spike	Weight of grains per spike	Weight of 1000 grains g	Grain yield kg/Fed	Straw yield kg/Fed
1	Control	6.00	15.50	27.25	1.14	41.99	257.5	482
2	75 kg N/Fed.	12.97	21.50	66.75	3.30	49.47	2916.0	5560
3	Azotobacter 200g/Fed. (A)	7.67	19.00	34.25	1.52	44.45	891.0	1820
4	Azospirillum 200g/Fed. (B)	8.35	18.00	35.75	1.60	44.87	1020.0	2050
5	100 A + 100g. B	9.15	17.50	34.25	1.52	44.59	989.7	2120
6	56.25 kg N/Fed+50g A/Fed	13.55	23.50	69.00	3.44	49.86	3009.4	5765
7	37.50kg N/Fed+100g A/Fed	12.50	21.50	55.25	2.56	46.34	2184.3	3820
8	18.75 kg N/Fed+150g A/Fed	10.70	19.00	44.25	1.99	45.08	1419.4	27.35
9	56.25 kg N/Fed+50g B/Fed	14.90	24.50	73.50	3.68	50.05	3058.2	6050
10	37.50 kg N/Fed+100g B/Fed	12.00	20.50	55.50	2.60	46.90	2194.5	4195
11	18.75 kg N/Fed+ 150g B/Fed	9.55	18.00	45.50	2.08	45.72	1617.4	2915
	L.S.D 5%	0.81	1.28	6.58	0.30	0.22	0.64	0.17

Table (8) : The interaction effect of bio and mineral fertilizers on spike length cm, number of spikelets, number of grains per spike, weight of grain per spike g, weight of 1000 grain g, grain yield kg/Fed and straw yield kg/Fed at harvest stage on wheat plant, season 1992/1993

No	Treatment	Spike length cm	No. of spikelets per spike	No. of grain per spike	Weight of grains per spike	Weight of 1000 grains g	Grain yield kg/Fed	Straw yield kg/Fed
1	Control	6.15	13.00	28.00	1.16	41.53	322.2	91.5
2	75 kg N/Fed.	12.22	21.50	67.75	3.40	49.44	2950.0	5755
3	Azotobacter 200g/Fed. (A)	8.02	17.50	39.50	1.68	44.27	909.4	2120
4	Azospirillum 200g/Fed. (B)	8.60	18.50	41.00	1.82	44.58	1018.5	2270
5	100 A + 100g. B	8.85	18.00	38.00	1.69	44.51	989.5	2145
6	56.25 kg N/Fed+50g A/Fed	12.65	22.00	71.75	3.58	49.95	3047.1	6125
7	37.50kg N/Fed+100g A/Fed	9.42	18.50	53.50	2.493	46.57	2054.7	43.05
8	18.75 kg N/Fed+150g A/Fed	8.15	17.50	42.50	1.93	45.45	1419.4	2935
9	56.25 kg N/Fed+50g B/Fed	13.60	23.50	75.50	3.80	50.42	3166.8	6260
10	37.50 kg N/Fed+100g B/Fed	9.20	19.00	56.00	2.63	47.01	2139.4	4590
11	18.75 kg N/Fed+ 150g B/Fed	7.75	15.50	44.50	2.04	45.94	1619.7	3065
	L.S.D 5%	0.70	1.50	3.75	0.21	0.24	0.49	0.09

at 75% of its recommended rate and either of ***Azotobacter sp*** or ***Azospirillum sp*** added at a rate of 50g/Fed resulted in greater spike length than that obtained due to fertilization with either the mineral or biofertilizers alone in both seasons of cultivation (1991/1992 and 1992/1993). The data was in agreement with those obtained by Rennie and Larson (1979) and Subba ***et al*** (1980) in their investigation on wheat.

4.1.1.5. <u>Number of spikelets per spike</u>:

Data in Tables (7 and 8) indicate that all the fertilization treatment increased significantly number of spikelets per spike.

Inoculation of the rhizosphere of wheat plant with either ***Azotobacter sp*** or ***Azospirillum sp*** alone yielded number of spikelets relatively low or than that yielded upon fertilization with the inorganic nitrogen at its recommended rate. The interaction effect of the combinations between the mineral fertilizers and the biofertilizers varied according to their proportions. The results indicate that the application of the mineral nitrogen at 75% of its recommended field rate in combination with 50g of either ***Azotobacter sp*** or ***Azospirillum sp*** seemed to be of the most favourable effect on number of spikelets. The effect of the fertilization treatments on number of spikelets in the second season of cultivation (1992/1993) although seemed to be less than that of the first season, yet the trends occurred in the first season were almost attained in the second one. These results are in agreement with those obtained by Yoav (1986) in his work on wheat.

4.1.1.6. <u>Number of grains per spike</u>:

Data in Tables (7 and 8) show numbers of grains per spike of wheat plant grown on soil in both 1991/1992 and 1992/1993 seasons. It is obvious from data that inoculating the rhizosphere of wheat plant with either of ***Azotobacter sp*** or ***Azospirillum sp*** although significantly increased number of grains per spike compared with the control treatment, yet the inoculation with these bacterial species resulted in much less number of grain per spike than that obtained upon fertilization with the recommended dose of the inorganic nitrogen fertilizer. However, the combinations between the bacterial inoculation of the rhizosphere and mineral fertilization tended to increase number of grains per spike compared with that obtained upon inoculation only. In this concern, the effect of the inorganic nitrogen (added at 75% of its recommended rate)-nitrogen fixers (***Azotobacter sp*** or ***Azospirillum sp***) added at a rate of 50g/Feddan, yielded the highest number of grains per spike. These results are in agreement with those obtained by El-Demerdash ***et al*** (1986) in his work on wheat.

4.1.1.7. <u>Weight of grain spike</u>:

The results given in Tables (7 and 8) illustrated that the response of weight of grain spikes to the different fertilization treatments varied widely. Although, all the treatments significantly increased weight of grain, yet inoculation of the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** alone resulted in grain spike of less weight than that obtained upon fertilizing the soil with the inorganic nitrogen at its recommended rate. The mineral fertilizer and the nitrogen fixers interaction seemed to be of highest effect on weight of grain spike upon addition of the inorganic nitrogen at 75% of its recommended field rate in combination with inoculation of the rhizosphere by ***Azotobacter sp*** or ***Azospirillum sp*** at a rate of 50g/Fed.

These results are in good agreement with those obtained by Saleh ***et al*** (1986) in his work on wheat.

4.1.1.8. Weight of 1000 grains:

Data presented in Tables (7 and 8) show that there was no markedly difference in weight of 1000 grain between wheat crop yield 1991/1992 and that of 1992/1993. Also, the different fertilization treatments affected the weight of 1000 grains of 1991/1992 crop yield in a manner similar to that by which the corresponding treatments affected the weight of 1000 grains of season 1992/1993 wheat crop yield.

Inoculation of the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** alone although significantly increased weight of 1000 grain, yet, it yielded a weight of 1000 grain less than that obtained due to fertilization with the recommended rate of the nitrogen fertilizer.

Associations between inoculation and mineral fertilization in different proportions seemed to be of variable effect on weight of 1000 grains.

Application of the mineral nitrogen fertilizer at 75% of its recommended rate associated with inoculation with 50g of either ***Azotobacter sp*** or ***Azospirillum sp*** was the fertilization treatment that gave the highest weight of 1000 grains.

The abovementioned results and discussion mean that the fertilization treatment composed of 75% of the recommended field rate of inorganic nitrogen and inoculation with 50g/Fed of either ***Azotobacter sp*** or ***Azospirillum sp*** resulted in higher yield and also reduced costs of nitrogen fertilization. Such conclusion stands in a good agreement with those of Inbal and Feldman (1982); Jain and Petriquin (1985) and Kapulnik ***et al*** (1985), in their investigation on wheat.

4.1.1.9. <u>The grain yield</u>:

The effect of fertilization treatments on the wheat grain yield were shown in Tables (7 and 8). The lowest yield was (257.5 kg/Fed) at control, while the highest yield was (3058.2 kg/Fed) at treatment (56.25 kg N/Fed + 50g/Fed ***Azospirillum sp***), (3009.4 kg/Fed) at treatment (56.25 kg N/Fed + 50 g/Fed, ***Azotobacter***) and (2916 kg/Fed) at season 1991/1992. It is evident from results that inoculating the plant rhizosphere with either of ***Azotobacter sp*** or ***Azospirillum sp*** at a rate of 50g/Fed associated with the mineral nitrogen fertilizer at three fourths of its recommended field rate was the most pronounced treatment in increasing grain yield of wheat. On the other hand, inoculating the plant rhizosphere only with either of the bacterial nitrogen fixers or, [200g/Fed ***Azotobacter*** or 200g/Fed ***Azospirillum***] or mixture (100g/Fed ***Azotobacter*** + 100g ***Azospirillum***) resulted 891, 1020 and 989.7 kg/Fed, respectively.

Also, the result in Tables (7 and 8) indicates that the grain yield decreased with decreasing of mineral fertlizers and increasing biofertilizers. It has shown that the grain yield (2184.3 kg/Fed) at treatment (37.5 kg N/Fed + 100 g/Fed ***Azotobacter*** and (2194.5 kg/Fed) at treatment (37.5 kg N/Fed + 100 g/Fed ***Azospirillum***) was lower than that achieved due to the fertilization by the recommended rate of the inorganic nitrogen.

The results in Tables (7 and 8) cleared that the most effective fertilization treatment was that composed of 75% of the recommended field rate of the mineral nitrogen and inoculation of the plant by rhizosphere 50 g/Fed of either ***Azotobacter sp*** or ***Azospirillum sp***. The obtained results and the given explanations are in close agreement with many of the previous studies, (Fayez, 1981; Zambre ***et al*** 1984; Sarig ***et al*** 1986 and Mercedes ***et al*** 1993) in their investigation on wheat.

4.1.1.10. The straw yield:

Straw yield as it is shown in Table (7 and 8) lowest was (482 kg/Fed) at control, while the highest yield was (6050 kg/Fed) at treatment (56.25 kg N/Fed) + 50 g/Fed ***Azospirillum***), (5765 kg/Fed) at treatment (56.25 kg N/Fed + 50 g/Fed ***Azotobacter sp***) and (5660 kg/Fed) at recommended rate (75 kg N/Fed) at season 1991/1992. It is evident from results that inoculating the plant rhizosphere with either of ***Azotobacter sp*** or ***Azospirillum sp*** at a rate of 50 g/Fed associated with the mineral nitrogen fertilizer at three fourths of its recommended field rate was the most pronounced treatment in increasing straw yield of wheat. On the other hand, inoculating the plant rhizosphere only with either of the bacterial nitrogen fixers or mixture [200 g/Fed ***Azotobacter*** or 200 g/Fed ***Azospirillum***) or (100 g/Fed ***Azotobacter*** + 100 g/Fed ***Azospirillum***) resulted 1820, 2050 and 2120 kg?Fed, respectively.

Also, from the result in Tables (7 and 8) indicates that the straw yield decreased with decreasing of mineral fertilizers and increasing biofertilizers. The results show that the straw yield (3820 kg/Fed) at treatment (37.5 kg N/Fed + 100 g/Fed ***Azotobacter***) and (4195 kg/Fed) at treatment (37.5 kg N/Fed + 100 g/Fed ***Azospirillum***).

The results in Tables (7 and 8) cleared that the most effective fertilization treatment was that composed of 75% of the recommended field rate of the mineral nitrogen and 50 g/Fed of either ***Azotobacter sp*** or ***Azospirillum sp*** . In otherwords, the inoculation of the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** resulted in a straw yield much less than that obtained by the plants fertilized with the recommended field rate of the inorganic nitrogen.

Many workers have observed similar observations Karunakar and Rajgopalan,1936; Cooper, 1959; Mahmoud *et al* 1981; Yoav, 1986 and Campbell *et al* 1993 in their investigation on wheat.

4.1.2. **Effect of mineral nitrogen fertilizer, inoculation with nitrogen fixers or interaction between mineral nitrogen fertilization inocullant on N, P and K concentration and uptake by wheat plant**:

4.1.2.1. **N, P and K concentration**:

Data presented in Tables (9, 10, 11 and 12) reveal that concentrations of N, P and K in wheat plant were increased significantly due to fertilization with the recommended rate of the inorganic nitrogen, inoculation with either ***Azotobacter sp*** or ***Azospirillum sp*** alone or in combination with the mineral fertilizer in different proportions.

Inoculating the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** resulted in lower concentrations of N, P and K in plants than the corresponding ones of the wheat plant fertilized with the recommended field rate of the inorganic nitrogen. On the other hand, the inoculation of the rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** at rate of 50 g/Fed accompanied with fertilization with inorganic nitrogen at 75% of its recommended field rate resulted in the highest concentrations of all the studied fertilizer elements. Moreover, other proportions between the mineral and organic fertilizer resulted in concentrations of N, P and K slightly lower than the highest corresponding concentrations in both seasons of cultivation (1991/1992 and 1992/1993) and at both stages of growth (45 and 100 days of planting). Such results indicated the possibility of substituting a considerable portion of the inorgnic fertilizer by inoculation with either of the ***Azotobacter sp*** or ***Azospirillum sp*** . These results are in

Table (9) : The interaction effect of bio and mineral fertilizers on conectration and uptake of N, P and k after 45 days from planting wheat in 1991/1992 season.

No	Treatment	Dry weight per plant (g)	1991/1992					
			Nutrients conectration %			Nutrients uptake mg/plant		
			N	P	K	N	P	K
1	Control	1.85	3.80	0.26	1.25	70.39	4.87	23.23
2	75 kg N/Fed.	8.15	4.27	0.38	2.46	348.54	31.39	200.90
3	Azotobacter 200g/Fed. (A)	3.47	4.03	0.29	1.93	140.35	10.09	66.97
4	Azospirillum 200g/Fed. (B)	3.62	4.12	0.31	1.95	149.56	11.20	73.43
5	100 A + 100g. B	4.72	3.96	0.28	1.88	146.78	13.46	88.77
6	56.25 kg N/Fed+50g A/Fed	8.47	4.66	0.40	2.55	395.12	34.91	220.32
7	37.50kg N/Fed+100g A/Fed	5.50	4.25	0.34	2.28	234.16	24.95	125.25
8	18.75 kg N/Fed+150g A/Fed	4.32	4.17	0.31	2.14	180.53	14.08	92.74
9	56.25 kg N/Fed+50g B/Fed	9.17	4.98	0.44	2.75	456.89	40.35	256.55
10	37.50 kg N/Fed+100g B/Fed	5.37	4.32	0.36	2.38	232.21	19.34	128.01
11	18.75 kg N/Fed+ 150g B/Fed	5.07	4.21	0.31	2.17	213.95	15.98	110.42
	L.S.D 5%	0.67	0.04	0.02	0.05	9.42	2.86	10.77

Table (10) : The interaction effect of bio and mineral fertilizers on conectration and uptake of N, P and k after 45 days from planting wheat in 1992/1993 season.

No	Treatment	Dry weight per plant (g)	1992/1993					
			Nutrients conectration %			Nutrients uptake mg/plant		
			N	P	K	N	P	K
1	Control	1.33	3.73	0.29	1.18	50.01	3.92	15.77
2	75 kg N/Fed.	8.35	4.32	0.40	2.52	360.99	28.31	179.31
3	Azotobacter 200g/Fed. (A)	2.00	4.11	0.28	1.89	77.82	5.64	37.87
4	Azospirillum 200g/Fed. (B)	2.42	4.16	0.32	1.94	100.95	7.96	46.99
5	100 A + 100g. B	2.07	4.09	0.285	1.79	84.84	10.64	40.70
6	56.25 kg N/Fed+50g A/Fed	8.85	4.58	0.43	2.62	405.46	38.25	209.49
7	37.50kg N/Fed+100g A/Fed	5.92	4.30	0.36	2.28	255.24	21.79	138.72
8	18.75 kg N/Fed+150g A/Fed	3.35	4.15	0.33	2.19	139.13	11.23	88.53
9	56.25 kg N/Fed+50g B/Fed	9.77	4.91	0.47	2.77	480.69	46.67	271.54
10	37.50 kg N/Fed+100g B/Fed	6.32	4.33	0.405	2.41	273.40	25.62	152.60
11	18.75 kg N/Fed+ 150g B/Fed	3.60	4.21	0.35	2.23	151.74	12.78	80.38
	L.S.D 5%	0.50	0.08	0.02	0.09	11.45	4.23	9.49

Table (11) : The interaction effect of bio and mineral fertilizers on conectration and uptake of N, P and k after 100 days from planting wheat in 1991/1992 season.

No	Treatment	Dry weight per plant (g)	1991/1992					
			Nutrients conectration %			Nutrients uptake mg/plant		
			N	P	K	N	P	K
1	Control	3.45	1.96	0.11	1.18	65.23	3.96	40.86
2	75 kg N/Fed.	13.60	2.44	0.19	2.01	331.83	26.37	273.66
3	Azotobacter 200g/Fed. (A)	7.92	2.11	0.14	1.52	142.50	11.02	121.03
4	Azospirillum 200g/Fed. (B)	7.67	2.16	0.14	1.54	141.25	10.76	11.67
5	100 A + 100g. B	7.65	2.12	0.13	1.48	161.97	10.03	113.26
6	56.25 kg N/Fed+50g A/Fed	13.65	2.57	0.23	2.11	351.36	32.04	288.74
7	37.50kg N/Fed+100g A/Fed	8.67	2.46	0.17	1.73	163.70	15.22	151.24
8	18.75 kg N/Fed+150g A/Fed	7.87	2.26	0.15	1.58	178.35	11.80	124.84
9	56.25 kg N/Fed+50g B/Fed	14.75	2.61	0.25	2.18	385.68	37.64	322.74
10	37.50 kg N/Fed+100g B/Fed	8.47	2.50	0.20	1.79	162.20	17.28	151.03
11	18.75 kg N/Fed+ 150g B/Fed	6.95	2.30	0.173	1.63	157.58	11.79	111.79
	L.S.D 5%	1.55	0.04	0.02	0.02	8.58	1.83	9.81

Table (12) : The interaction effect of bio and mineral fertilizers on conectration and uptake of N, P and k after 100 days from planting wheat in 1992/1993 season.

No	Treatment	Dry weight per plant (g)	1992/1993					
			Nutrients conectration %			Nutrients uptake mg/plant		
			N	P	K	N	P	K
1	Control	3.17	1.92	0.14	0.97	61.22	4.60	30.87
2	75 kg N/Fed.	14.100	2.46	0.26	2.12	346.65	29.28	246.46
3	Azotobacter 200g/Fed. (A)	6.60	2.15	0.16	1.41	142.09	12.66	101.63
4	Azospirillum 200g/Fed. (B)	5.65	2.19	0.17	1.47	123.99	10.61	83.02
5	100 A + 100g. B	5.57	2.14	0.19	1.41	119.78	16.82	78.42
6	56.25 kg N/Fed+50g A/Fed	15.10	2.60	0.28	2.17	374.68	36.77	328.40
7	37.50kg N/Fed+100g A/Fed	6.95	2.50	0.21	1.78	180.10	22.11	158.93
8	18.75 kg N/Fed+150g A/Fed	5.20	2.30	0.19	1.63	119.92	10.13	85.09
9	56.25 kg N/Fed+50g B/Fed	14.47	2.65	0.32	2.20	384.32	47.10	319.54
10	37.50 kg N/Fed+100g B/Fed	9.15	2.53	0.23	1.83	240.94	21.51	167.90
11	18.75 kg N/Fed+ 150g B/Fed	5.65	9.34	0.21	1.67	132.45	11.92	96.94
	L.S.D 5%	1.52	0.03	0.02	0.03	8.99	8.96	9.44

agreement with those obtained by Madkour (1972); Rennie and Larson (1979) and Ishac ***et al*** (1986) in their investigation on wheat.

4.1.2.2. <u>N, P and K uptake</u> :

Plant uptake of N, P and K increased significantly by fertilizing the plant with the recommended field rate of the inorganic nitrogen Tables (9, 10, 11, 12, 13 and 14).

Similar significant increases in N, P and K uptake occurred due to inoculating the rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** . However, the uptake of N, P and K upon inoculating the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** resulted in much less uptake of N, P and K than that resulted in upon fertilization with the recommended field rate of inorganic nitrogen. The combinations between the inorganic fertilization and the inoculation with either ***Azotobacter sp*** or ***Azospirillum sp*** resulted in significant increases in N, P and K uptake. Seventy five percent of the recommended rate of the inorganic nitrogen combined with 50 g/Fed of the biofertilizer resulted in the highest N, P and K uptake by plant. The effects of the different fertilization treatments on N, P and K uptake by wheat plant in 1992/1993 season coincided with the corresponding ones on uptake of N, P and K in 1991/1992 season.

Also, N, P and K uptake followed similar trends at both stages of growth (45 and 100 days after cultivation). These results are in agreement with those obtained by Zambre ***et al*** (1984) in his work on wheat.

4.1.2.3. <u>Concentration of N, P and K in wheat grains</u>:

Data in Tables (13 and 14) show that concentrations of N, P and K in grains of wheat grown in 1991/1992 and 1992/1993 seasons significantly

Table (13) : The interaction effect of bio and mineral fertilizers on grain yield kg /Fed., concentration and uptake of N, P and k by wheat grains in 1991/1992 season.

No	Treatment	Grain yield kg/Fed.	1991/1992					
			Nutrients conectration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	257.5	1.67	0.10	0.16	4.61	0.29	0.41
2	75 kg N/Fed.	2916.0	2.31	0.17	0.47	67.54	5.10	13.58
3	Azotobacter 200g/Fed. (A)	891.0	1.97	0.13	0.23	18.01	1.18	7.10
4	Azospirillum 200g/Fed. (B)	1020	1.97	0.12	0.27	20.17	1.27	2.83
5	100g A + 100 g B	989.7	1.99	0.11	0.25	19.71	1.09	2.55
6	56.25 kg N/Fed+50g A/Fed	3009.4	2.33	0.20	0.51	70.50	6.33	15.46
7	37.50kg N/Fed+100g A/Fed	2184.3	2.17	0.16	0.37	44.74	3.39	8.34
8	18.75 kg N/Fed+150g A/Fed	1419.4	2.14	0.13	0.33	30.45	2.03	4.75
9	56.25 kg N/Fed+50g B/Fed	3058.2	2.37	0.23	0.55	74.33	6.66	17.37
10	37.50 kg N/Fed+100g B/Fed	2194.5	2.21	0.19	0.41	47.40	4.12	8.87
11	18.75 kg N/Fed+ 150g B/Fed	1617.4	2.13	0.15	0.37	34.58	2.51	6.07
	L.S.D 5%	0.64	0.07	0.02	0.02	1.79	0.88	4.41

Table (14) : The interaction effect of bio and mineral fertilizers on grain yield, conectration and uptake of N, P and k by wheat grains in 1992/1993 season.

No	Treatment	Grain yield kg/Fed.	1992/1993					
			Nutrients conectration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	322.2	1.78	0.13	0.21	5.73	1.11	0.69
2	75 kg N/Fed.	2950.0	2.26	0.24	0.52	66.01	7.22	15.26
3	Azotobacter 200g/Fed. (A)	909.4	1.88	0.15	0.26	19.79	1.63	2.78
4	Azospirillum 200g/Fed. (B)	1018.5	1.94	0.16	0.30	21.86	1.80	3.31
5	100 A + 100g. B	989.5	2.05	0.18	0.27	22.04	1.95	2.89
6	56.25 kg N/Fed+50g A/Fed	3047.1	2.31	0.27	0.58	69.68	8.27	14.57
7	37.50kg N/Fed+100g A/Fed	2054.7	2.18	0.20	0.41	47.67	4.42	8.84
8	18.75 kg N/Fed+150g A/Fed	1419.4	2.12	0.19	0.37	31.00	4.70	5.46
9	56.25 kg N/Fed+50g B/Fed	3166.8	2.37	0.31	0.62	74.33	9.86	14.64
10	37.50 kg N/Fed+100g B/Fed	2139.4	2.18	0.22	0.45	47.95	4.94	10.12
11	18.75 kg N/Fed+ 150g B/Fed	910.5	2.13	0.20	0.39	36.68	3.44	6.80
	L.S.D 5%	0.49	0.09	0.02	0.02	1.91	1.80	3.63

increased due to fertilization with the recommended rate of the mineral nitrogen alone, inoculation with either ***Azotobacter sp*** or ***Azospirillum sp*** alone or fertilization with the mineral nitrogen combined with either ***Azotobacter sp*** or ***Azospirillum sp*** at different proportions.

Inoculation of the plant rhizosphere with either of ***Azotobacter sp*** or ***Azospirillum sp*** alone resulted in concentration of N, P and K in wheat grains obviously lower than those of the grain of the wheat plant fertilized with the recommended level of the mineral nitrogen. However, the combination between the mineral nitrogen (added to the soil at 75% of recommended rate) and either of ***Azotobacter sp*** or ***Azospirillum sp*** (added at a rate of 50 g/Fed) showed slightly higher concentrations of the three fertilizer elements than the solely addition of the mineral fertilizer at its recommended rate. The other combinations between the mineral fertilizer and inoculation with either of the bacterial species resulted in lower concentrations of N, P and K than the aforementioned treatment. These results are in agreement with those obtained by El-Haddad ***et al*** (1986) in his work on wheat.

4.1.2.4. Uptake of N, P and K in wheat grains:

As the uptake of a certain element is a product of the dry matter yield multiplied by the concentration of this element, the uptake of N, P and K followed trends, due to the different fertilization treatments, coincide with those previously noticed with both of dry matter yield and concentrations of the studied elements under the corresponding fertilization treatments.

Data in Tables (13 and 14) reveal that the wheat plant uptake of N, P and K in both seasons of study (1991/1992 and 1992/1993) increased significantly due to fertilization with the inorganic (mineral) nitrogen fertilizer or the biofertilizers.

The N, P and K uptake was highest by the plants fertilized with 75% of the recommended rate of the inorganic nitrogen combined with inoculation with 50 g/Fed of either ***Azotobacter sp*** or ***Azospirillum sp*** . On the other hand, inoculating the plant rhizosphere with either of ***Azotobacter sp*** or ***Azospirillum sp*** only resulted in N, P and K uptake much less than that of the plant fertilized with the mineral fertilizer at its recommended field rate. Also, the combinations between the mineral nitrogen and ***Azotobacter sp*** at a given proportion seemed to be of less effect on N, P and K uptake than the combinations between the mineral fertilizer and ***Azospirillum sp*** at a corresponding proportion. These results are in agreement with those obtained by El-Mokadem ***et al*** (1986) in his work on wheat.

4.1.2.5. Concentrations of N, P and K in wheat straw:

Concentrations of N, P and K in wheat straw (Tables 15 and 16) increased significantly due to the mineral and bio-fertilization as well as the different combinations between the two types of fertilizers.

The differences between the fertilizer elements concentration although seemed to be slight, yet these differences were in most cases significant. The fertilization treatment composed of both the recommended field rate of the inorganic nitrogen combined by inoculation with 50 g/Fed of either of ***Azotobacter sp*** or ***Azospirillum sp*** resulted in the highest concentrations of the three studied elements.

Relatively lower concentration of N, P and K were found in wheat straw upon inoculating the plant rhizosphere with either ***Azotobacter sp*** or ***Azospirillum sp*** only. Also, the other combinations between the mineral

Table (15) : The interaction effect of bio and mineral fertilizers on straw yield, conectration and uptake of N, P and k by wheat straw in 1991/1992 season.

No	Treatment	straw yield kg/Fed.	1991/1992					
			Nutrients conectration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	482	0.18	0.05	0.33	0.91	0.23	1.61
2	75 kg N/Fed.	5660	0.26	0.07	0.58	14.99	4.45	33.11
3	Azotobacter 200g/Fed. (A)	1820	0.23	0.06	0.38	4.34	1.15	7.00
4	Azospirillum 200g/Fed. (B)	2050	0.24	0.06	0.42	5.02	1.36	8.75
5	100 A + 100g. B	2120	0.24	0.06	0.38	5.19	1.33	8.31
6	56.25 kg N/Fed+50g A/Fed	5765	0.28	0.08	0.62	15.55	5.04	36.03
7	37.50kg N/Fed+100g A/Fed	3820	0.28	0.07	0.47	10.70	2.69	18.14
8	18.75 kg N/Fed+150g A/Fed	2735	0.26	0.06	0.44	7.17	1.98	12.16
9	56.25 kg N/Fed+50g B/Fed	6050	0.30	0.09	0.66	18.45	5.47	40.40
10	37.50 kg N/Fed+100g B/Fed	4195	0.28	0.07	0.51	11.74	3.22	21.65
11	18.75 kg N/Fed+ 150g B/Fed	2915	0.27	0.06	0.46	7.86	1.96	13.55
	L.S.D 5%	0.17	0.02	0.00	0.02	0.97	0.26	1.23

Table (16) : The interaction effect of bio and mineral fertilizers on straw yield, conectration and uptake of N, P and k by wheat straw in 1992/1993 season.

No	Treatment	Straw yield kg/fed.	19921993					
			Nutrients conectration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	915	0.24	0.06	0.35	2.24	0.60	3.51
2	75 kg N/Fed.	5755	0.28	0.09	0.61	16.52	5.26	35.39
3	Azotobacter 200g/Fed. (A)	2120	0.26	0.06	0.38	5.66	1.40	8.15
4	Azospirillum 200g/Fed. (B)	2270	0.25	0.07	0.45	5.71	1.60	10.21
5	100 A + 100g. B	2145	0.27	0.06	0.44	5.95	1.43	9.72
6	56.25 kg N/Fed+50g A/Fed	6125	0.29	0.09	0.65	17.91	5.88	40.11
7	37.50kg N/Fed+100g A/Fed	4305	0.28	0.08	0.52	12.37	3.76	22.48
8	18.75 kg N/Fed+150g A/Fed	2935	0.26	0.07	0.48	7.77	2.15	14.15
9	56.25 kg N/Fed+50g B/Fed	6260	0.30	0.10	0.69	18.78	6.71	43.50
10	37.50 kg N/Fed+100g B/Fed	4590	0.28	0.09	0.55	13.07	4.12	25.48
11	18.75 kg N/Fed+ 150g B/Fed	3065	0.26	0.07	0.49	8.19	2.33	15.24
	L.S.D 5%	0.09	0.02	0.01	0.03	0.85	0.28	0.90

nitrogen fertilizer and inoculation with either of the two bacterial sp resulted in concentrations of N, P and K in the plant straw not a from those shown due to the other fertilization treatments. These results are in agreement with those obtained by Darmwal and Gaur (1988) in their work on wheat.

4.1.2.6. <u>Uptake of N, P and K by wheat straw</u>:

The amounts of N, P and K taken up by wheat straw are given in Tables (15 and 16).

It is obvious from data that this uptake significantly increased due to inoculating the wheat rhizosphere with either of the ***Azotobacter sp*** or ***Azospirillum sp*** or fertilizing the soil with the recommended field rate of inorganic nitrogen or inoculation with either of the bacterial species combined with the mineral fertilizer in different proportions.

Inoculating the rhizosphere with ***Azotobacter sp*** or ***Azospirillum sp*** alone although resulted in significant increase in straw uptake of N, P and K compared with the control treatment, yet, this increase was much less than that occurred upon fertilizing the soil with the recommended rate of the mineral fertilizer. The combinations between inoculation and mineral fertilization caused more N, P and K uptake, especially the treatment composed of 75% of the field recommended rate of the inorganic nitrogen and 50 g/Fed of the biofertilizer elements. Moreover, the mineral fertilizer and the ***Azospirillum sp*** interaction was more pronounced in increasing N, P and K uptake than the interaction of the mineral fertilizer combined with ***Azotobacter sp***. Such results assure the necessity of the biofertilizers in reduce costs of fertilization and achieveing a good quality and quantity crop yield.

The obtained results and the given explanations are in close agreement with many of the previous studies. Omar ***et al*** 1991; Abass ***et al*** 1994 and Ishac 1994 in their investigation on wheat.

4.1.3. <u>Chemical composition of wheat grains</u>:

Tables (17, 18 and 19) presented results of proximate composition and chemical analysis of wheat (Giza 164). The obtained data indicate the interaction effect of biofertilizers and mineral fertilizers on wheat grains (Giza 164) (g/100 g on dry wheat basis) during 1991/1992 and 1992/1993 seasons.

The obtained results illustrate that there are slight differences between the two seasons in moisture, crude protein, total carbohydrate and ash at all the treatment.

Tables (17 and 18) show that the protein content of wheat grains frequently increases at the treatments (56.25 Kg N/Fed + 50 g/Fed ***Azotobacter sp*** and (56.25 kg N/Fed + 50 g/Fed ***Azospirillum***).

These results are in agreement with that reported by Darmwall and Gaour (1988). Also, the obtained data indicate that the treatments of (56.25 kg N/Fed + 50 g/Fed ***Azotobacter sp***) and (56.25 kg N/Fed + 50 g/Fed ***Azospirillum sp***) caused the highest protein value i.e. 15.14% in comaprison with the control value.

Total carbohydrates content of wheat grains (Giza 164) ranged between (81.29-84.73%) for 1991/1992 season and (80.70-83.61%) for 1992/1993 season. These results are in coincident with that mentioned by Tsen (1985).

Table (19) illustrated that the control treatment occurred the highest starch content i.e. 76.16%.

Table (17) : The interaction effect of bio and mineral fertilizers on chemical costituents of wheat grain (g/100g dry weight basis) in 1992 season.

No	Treatment	1992					
		Moisture %	Carboh-ydrate %	Crude protein %	Ash %	Crude protein kg/Fed	Total carbohydrate kg/Fed
1	Control	9.53	84.73	10.56	3.03	27.19	218.17
2	75 kg N/Fed.	11.50	81.79	14.90	2.30	434.48	2384.99
3	Azotobacter 200g/Fed. (A)	10.50	83.24	12.60	2.86	112.26	741.66
4	Azospirillum 200g/Fed. (B)	10.58	83.14	12.60	2.73	128.52	848.02
5	100 A + 100g. B	10.60	82.86	12.69	2.82	125.59	820.06
6	56.25 kg N/Fed+50g A/Fed	11.88	81.29	15.14	2.37	544.62	2446.34
7	37.50kg N/Fed+100g A/Fed	11.25	82.26	13.97	2.51	305.14	17.96.80
8	18.75 kg N/Fed+150g A/Fed	11.03	82.28	13.74	2.74	195.02	1167.88
9	56.25 kg N/Fed+50g B/Fed	12.23	81.58	15.14	2.26	463.01	2494.87
10	37.50 kg N/Fed+100g B/Fed	11.78	81.71	14.30	2.56	313.81	1793.12
11	18.75 kg N/Fed+ 150g B/Fed	11.30	81.84	13.71	2.74	221.74	1323.68

Table (18) : The interaction effect of bio and mineral fertilizers on chemical costituents of wheat grain (g/100g dry weight basis) in 1993 season.

No	Treatment	1993					
		Moisture %	Carboh-ydrate %	Crude protein %	Ash %	Crude protein kg/Fed	Total carbohydrate kg/Fed
1	Control	9.250	83.61	11.22	3.37	36.15	269.39
2	75 kg N/Fed.	12.25	80.97	14.69	2.44	433.35	2388.61
3	Azotobacter 200g/Fed. (A)	11.25	84.45	12.12	2.87	110.21	767.98
4	Azospirillum 200g/Fed. (B)	11.45	82.87	12.50	2.73	127.31	844.03
5	100 A + 100g. B	11.43	82.91	13.19	2.79	130.51	820.39
6	56.25 kg N/Fed+50g A/Fed	12.83	81.10	15.13	2.38	466.20	2471.19
7	37.50kg N/Fed+100g A/Fed	12.43	82.25	14.18	2.54	291.35	1689.99
8	18.75 kg N/Fed+150g A/Fed	12.05	82.34	13.81	2.63	196.01	1168.73
9	56.25 kg N/Fed+50g B/Fed	12.50	80.70	15.46	2.25	489.58	2555.60
10	37.50 kg N/Fed+100g B/Fed	12.07	81.78	14.16	2.41	302.93	1749.60
11	18.75 kg N/Fed+ 150g B/Fed	12.33	82.15	13.84	2.52	126.01	747.97

Table (19) : The interaction effect of bio and mineral fertilizers on chemical composition of wheat grain (g/100g dry weight basis) in 1992 season.

No	Treatment	1993					
		Wet Gluten %	Dry Gluten %	Starch %	T.S.S %	Reducing sugar %	Non.reducing sugar %
1	Control	30.90	10.11	76.16	6.12	0.48	5.64
2	75 kg N/Fed.	32.14	11.34	70.89	8.16	0.99	7.17
3	Azotobacter 200g/Fed. (A)	31.53	10.10	76.09	6.87	0.86	6.01
4	Azospirillum 200g/Fed. (B)	31.63	11.11	74.25	6.93	0.89	6.04
5	100 A + 100g. B	31.92	11.21	74.23	6.90	0.88	6.02
6	56.25 kg N/Fed+50g A/Fed	32.95	12.34	71.36	8.34	1.02	7.43
7	37.50kg N/Fed+100g A/Fed	32.32	12.12	72.04	8.03	0.97	7.06
8	18.75 kg N/Fed+150g A/Fed	32.21	12.01	73.73	7.87	0.93	7.14
9	56.25 kg N/Fed+50g B/Fed	33.14	12.67	71.39	8.10	1.01	7.09
10	37.50 kg N/Fed+100g B/Fed	32.59	12.36	72.75	7.97	0.98	6.99
11	18.75 kg N/Fed+ 150g B/Fed	32.41	12.09	73.88	7.86	0.95	6.91

While the treatment of (56.25 kg N/Fed + 50 g/Fed ***Azotobacter***) and (56.25 kg N/Fed + 50 g/Fed ***Azospirillum***) caused the lowest starch content i.e. 71.36% and 71.39%, respectively.

Also, the obtained data indicate that the treatment No.6 (56.25 kg N/Fed + 50 g/Fed ***Azotobacter***) and No.9 (56.25 kg N/Fed + 50 g/Fed ***Azospirillum***) caused the highest crude protein content. On the other hand, these treatments achieved the lowest values in both carbohydrate and starch components. The results may be due to inversion of some of carbohydrate polymers to the protein component during the ripening stage.

Generally, the obtained results are in agreement with that obtained by Boyaciogiu and D'Appolonia (1994).

Dry and wet gluten were determined and recorded in Table (19).

The obtained data indicated that wet gluten ranged from 30.90 to 32.95%. While, dry gluten varied from 10.11% to 12.67%. From these results, it could be observed that the treatments of (56.25 kg N/Fed + 50 g/Fed ***Azotobacter***) and (56.25 kg N/Fed + 50 g/Fed ***Azospirillum***) acquired the highest values.

Also, the obtained results illustrate that the percentages of dry and wet gluten are in accordance with the values of protein content for the different treatments as shown in Tables (17, 18 and 19).

The obtained results are in agreement with that obtained by Kaldy ***et al*** (1993).

Total soluble sugars, reducing and non-reducing sugars were estimated and illustrated in Table (19). The obtained data show that the different treatments caused increments in total soluble sugars varied from 33.33 to 12.25% in comparison with control treatment. On the other hand, there are noticeable increments in reducing sugars for different treatments. At the same time, these increments were accompanied with decrements in non-reducing sugars, if compared with control treatment.

In general, the obtained data are in agreement with that obtained by Hanaa ***et al*** (1993).

4.1.4. Follow-up of total nitrogen and available P and K of the wheat-cultivated soil due to fertilization:

Results of the follow up of the soil contents of total nitrogen, available P and K due to the different fertilization treatments are given in Tables (20 and 21). Data reveal that in both seasons of cultivation, soil contents of the three fertilizer elements were higher upon fertilizing the soil with urea (at 75% of its field recommended level) combined with 50 g/Fed of ***Azospirillum sp*** inoculated at the plant rhizosphere. The same rate of the urea combined with 50 g/Fed of the ***Azotobacter sp*** resulted in slightly lower concentrations of N, P and K in soil. On the other hand, inoculating the rhizosphere with either of ***Azotobacter sp*** or ***Azospirillum sp*** separately or together increased the soil content of total N compared with the control treatment over the whole period of study. Yet, this increase was lower than those cased due to fertilization with the recommended field rate of the urea or the fertilization treatments composed of three fourths of the recommended rate of urea combined with either of the nitrogen fixers at different proportions. The distribution of total nitrogen within both seasons of cultivation show that concentration of the total nitrogen tended to decrease with time i.e, it was higher after 45 days of cultivation and lower at the harvesting stage. It is well known that the decrease of nitrogen percent is due to leaching, volatilization and plant consumption.

The soil content of the available P seemed to be affected by the different fertilization treatments in a way similar to a great extent, to that of total nitrogen. This was true in both seasons of cultivation and over the whole period of each season.

The different fertilization treatments affected the soil content of the available K to floculate within a narrow range of concentrations.

Stage of growth showed no certain effect on K concentration.

Also, no variation could be achieved in K concentration between the two seasons of cultivation.

The obtained results and the given explanations are in close agreement with many of the previous studies (Boddey and Dobereiner 1988; Skinner ***et al*** 1989 and Quispel 1991).

Table (20) : The interaction effect of bio and mineral fertilizers wheat cultivated soil content of on total nitrogen, available P and K at 45 and 100 days after sowing and after harvest in 1991/1992 season .

No	Treatment	Season 1991/1992								
		at 45 days			at 100 days			at harvest		
		Total N %	Avaiable P ppm	Available K me/100g	Total N %	Avaiable P ppm	Available K me/100g	Total N %	Avaiable P ppm	Available K me/100g
1	Control	0.162	12.17	1.82	0.113	11.11	0.99	0.098	10.11	0.81
2	75 kg N/Fed.	0.332	22.11	1.75	0.281	19.18	1.34	0.219	16.15	0.98
3	Azotobacter 200g/Fed. (A)	0.202	13.61	1.53	0.182	12.15	1.11	0.171	11.10	0.84
4	Azospirillum 200g/Fed. (B)	0.209	14.46	1.61	0.188	12.87	1.16	0.176	11.90	0.85
5	100 A + 100g. B	0.205	13.49	1.57	0.184	12.72	1.13	0.172	11.65	0.85
6	56.25 kg N/Fed+50g A/Fed	0.345	22.76	1.81	0.283	20.15	1.39	0.227	18.07	0.99
7	37.50kg N/Fed+100g A/Fed	0.328	17.23	1.71	0.217	16.75	1.32	0.186	15.12	0.94
8	18.75 kg N/Fed+150g A/Fed	0.299	15.75	1.61	0.199	14.12	1.28	0.171	13.12	0.90
9	56.25 kg N/Fed+50g B/Fed	0.349	24.08	1.88	0.299	21.88	1.45	0.256	19.12	1.03
10	37.50 kg N/Fed+100g B/Fed	0.332	18.37	1.80	0.231	17.12	1.36	0.191	16.11	0.97
11	18.75 kg N/Fed+ 150g B/Fed	0.310	16.18	1.73	0.206	15.10	1.31	0.180	15.10	0.93

Table (21) : The interaction effect of bio and mineral fertilizers wheat cultivated soil content of total nitrogen, available P and K at 45 and 100 days after sowing and after harvest in 1992/1993 season.

No	Treatment	Season 1991/1992								
		at 45 days			at 100 days			at harvest		
		Total N %	Avaiable P ppm	Available K me/100g	Total N %	Avaiable P ppm	Available K me/100g	Total N %	Avaiable P ppm	Available K me/100g
1	Control	0.168	13.04	1.22	0.122	12.16	1.04	0.099	11.12	0.86
2	75 kg N/Fed.	0.343	22.40	1.83	0.286	20.19	1.41	0.228	17.23	1.01
3	Azotobacter 200g/Fed. (A)	0.206	14.40	1.64	0.191	12.37	1.15	0.174	11.17	0.87
4	Azospirillum 200g/Fed. (B)	0.212	14.81	1.71	0.196	13.54	1.21	0.179	12.67	0.89
5	100 A + 100g. B	0.210	13.87	1.66	0.195	12.80	1.17	0.176	11.86	0.87
6	56.25 kg N/Fed+50g A/Fed	0.348	24.08	0.91	0.296	21.63	1.45	0.229	19.10	1.06
7	37.50kg N/Fed+100g A/Fed	0.333	18.92	1.89	0.227	17.32	1.38	0.191	16.15	0.89
8	18.75 kg N/Fed+150g A/Fed	0.302	16.32	1.84	0.206	15.03	1.32	0.179	13.87	0.93
9	56.25 kg N/Fed+50g B/Fed	0.361	24.87	1.99	0.306	22.12	1.98	0.234	20.12	1.11
10	37.50 kg N/Fed+100g B/Fed	0.340	19.62	1.91	0.240	18.12	1.42	0.194	17.11	1.04
11	18.75 kg N/Fed+ 150g B/Fed	0.317	17.25	1.84	0.211	17.12	1.36	0.184	16.12	0.97

Part II:

4.2. Growth parameters and N, P and K uptake of soybean plants.

4.2.1. Effect of biofertilizers and mineral fertilizers on growth parameters of soybean plant :

Data presented in Tables (22, 23, 24, 25, 26 and 27 elucidate the effect of the investigated mineral fertilizers (superphosphate and rock phosphate) and biofertilizers (***Phosphorine and Mycorrhizal***) applied to the soil solely or in different combinations on plant height, number of tillers, dry weight and number of bods at different stages of growth.

4.2.1.1. Plant height :

It is evident from results that, at all growth stages, both the mineral and biofertilization with P significantly increased plant height as compared with its height upon receiving no fertilizers. Worthy mentioing that, application of the biofertilizers, i.e. (***Phosphorine and Mycorrhizal***) yielded much less plant height than that resulted in due to application of the superphosphate but almost similar to that yielded by the rock phosphate. These results are in accordance with those obtained by Baz ***et al*** (1984) who found that application of the phosphorus fertilizers to soybean plants significantly increased thier vegetative growth.

Regarding the effect of the different combinations of the mineral and biofertilizers, data reveal that application of any of the mineral fertilizers at 75% of its recommended rate in combination with one fourth of the suggested rate of either (***Phosphorine or Mycorrhizal***) 50 g/Fed resulted in plant height equal or even higher than that produced upon application of the corresponding mineral fertilizer at its recommended rate, Decreasing rate of the P mineral form and at the same time, increasing rate of the accompanied biological one tended to reduce plant height, however, this height remained significantly higher than that of the control plant. The equal sharing of (***Phosphorine and Mycorrhizal***) yielded plant height differing slightly from that produced due to application of each of them solely.

Comparison of data presented in Tables 22 and 23 with those presented in Tables 24, 25, 26 and 27 reveal that plant heights during season 1992 after 45 and 75 days of cultivation, did not differ from the corresponding ones of season 1993.

However, under the different fertilization treatments, at the harvest stage, height of the plants cultivated in season 1992 were obviously less than the corresponding ones of the plants grown in season 1993 (Tables 26 and 27). The residual effect of the mineral phosphatic fertilizers as well as the biofertilizers applied within 1992 and 1993 seasons seemed to take place in enriching the soil with available P and consequntly increasing plant height. These results are in agreement with those obtained by Abdel-Nasser ***et al.***, (1986).

4.2.1.2. <u>Number of tillers</u> :

Data presented in Tables 22, 23, 24, 25, 26 and 27 reveal that number of tilleres was significantly effected by the application of phosphorus in its mineral forms as well as the biofertilizers. The results indicate to the superiority of the super phosphate fertilizer over the rock phosphate or the biofertilizers. However application of the biofertilizers yielded number of tillers less then that yielded upon fertilization with rock phosphate at its recommended rate.

Application of the mineral phosphate as super phosphate or rock phosphate in combinations with either of (***Phosphorine and Mycorrhizal***) at

Comparing dry weight of plant after 45 or 75 days of cultivation in the first season (1992) with the corresponding one in the second season (1993) revealed that the effect of the investigated fertilization treatments on plant dry weight differed slightly from one.

These data was in agreement with thise obtained by Azcon *et al* (1976).

4.2.1.4. <u>Number of bods per plant</u> :

Data presented in Tables (26 and 27) reveal thar the different fertilization treatments affected significantly number of bods per plant. Super phosphate seemed to be the most effective fertilizer in this concern. The effect of the rock phosphate on number of bods is similar to that of the biofertilizers i.e. (***Phosphorine and Mycorrhizal***).

Fertilization with 16.5 P_2O_5/Fed. in the form of super phosphate (¾ the recommended rate combined with one fourth of the recommended rate of Phosphorine or Mycorrhizal (50 g.) yielded number of bods per plant equivalent, to a great extent to that yielded by the recommended rate of the super phosphate (22.0 kg P_2O_5/Fed.). Comparatively lower number of bods per plant was obtained due to fertilization of soils with the different combinations of rock phosphate with each of the studied biofertilizers. The abovementioned results and trends did not vary widely from 1992/1993 season to the next one, yet it is obvious that number of bods per plant in the harvest stage was much higher than that after 75 days of cultivation. These data were agreement with those obtained by Mosse *et al* (1976).

4.2.1.5. <u>Number of seeds per plant</u> :

It can be observed from data in Tables (26 and 27) that fertilization of soil by any of the studied fertilization treatments : significantly increased number of seeds per plant compared with that number in the absences of fertilization.

The super phosphate applied at its recommended rate (22.0 kg P_2O_5/Fed.) yielded higher number of seeds per plant than the rock phosphate, Phosphorine or Mycorrhizal., However biofertilizers seemed to be more obvious than that of rock phosphate.

Combinations between the super phosphate at a rate of three fourths of its recommended rate (16.5 kg P_2O_5/Fed.) and either of Phosphorine or Mycorrhizal at a rate of one fourth of recommended rate (50 g./Ped) seemed to be the most effective treatment on number of seeds per plant.

Moreover, ***Mycorrhizal*** was suoerior over ***Phosphorine*** in these combinations. The abovementioned trends took place at the harvesting stage on both the seasons of cultivation, i.e. 1992 and 1993, yet it is worthy to mention that number of seeds per plant in the first season was lower than the corresponding one in the second season regardless of the fertilizer treatment. It is important to say that the residual effect of the prceeding mineral and biofertilization might be considered the responsible factor of the increase in the number of seeds per plant.

These data was in agreement with those obtained by Carling ***et al.*** (1978).

4.2.1.6. <u>Weight of seeds per plant</u> :

Data in Tables (26 and 27) indicate that super phosphate yielded higher weight of seeds per plant than that yielded by rock phosphate or any of the studied biofertilizers. Generally it can be said that which received no fertilizers, the mineral and biofertilizerd plants yielded significant increase in weight of seeds. The treatment which consisted of 16.5 kg P_2O_5 per feddan as super phosphate + 50 g ***Mycorrhizal*** resulted in the highest weight of seeds per plant. A relatively lower weight of seeds per plant took place in the plants that were fertilized with the a foremenationed rate of super phosphate + 50 g. phosphorine. The increase in weight of seeds per plant due to the a formentioned treatments is closely related to the increase in number of seeds per plant. Also, the higher weight of seeds per plant in the second season than the first ones is a subsequent result of the higher number of seeds per plant in season 1993 than in season 1992.

These data were in agreement with those obtained by Hayman and Mosse (1971).

4.2.1.7. <u>Weight of 1000 seeds</u> :

Tables (26 and 27) show that the weight of 1000 seeds was affected significantly by the different fertilization treatments. In this concern, the treatment composed of 16.5 kg P_2O_5/Fed. super phosphate + 50 g. of mycorrhizal was the best followed by the treatment composed of the same level of super phosphate + 50 g. of phosphorine. The comparison between the fertilizers added solely reveal that super phosphate yielded a weight of 1000 seeds higher than that yielded by rock phosphate. Meanwhile the mycorrhizal yielded higher weight of 1000 seeds than that produced due to fertilization with phosphorine. Values of weight of 1000 seeds per plant due to the different fertilization treatments were lower in the first cultivation season than the second one. This is probably attributed to the additional effect of resisdual phosphorus on plant growth and consquently weight of seeds.

Table (22) : The interaction effect of bio and mineral fertilizers on plant height number of tillers and dry weight after 45 days from planting soybean in 1992 season.

No	Treatment	Plant height cm	Number of tillers	Dry weight gm.
1	Control	36.63	1.75	5.05
2	22 P_2O_5 kg/Fed super phosphate	57.90	3.00	8.30
3	22 P_2O_5 kg/Fed Rock phosphate	44.78	2.25	6.93
4	Phosphorine 200 g./Fed (C)	45.60	2.25	6.98
5	Mycorrhizal 200 g/Fed (D)	44.13	2.25	7.10
6	100 g /Fed C. + 100 g/Fed (D)	44.18	2.75	6.68
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	58.43	3.00	8.38
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	48.75	2.75	7.33
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	42.30	2.50	6.95
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	58.20	3.25	6.63
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	50.57	3.00	7.40
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	43.07	3.00	6.37
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	45.72	4.00	7.17
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	43.67	3.00	6.62
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	41.30	3.00	6.47
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	45.45	4.00	6.87
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	42.47	3.00	6.50
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	41.50	3.00	6.45
	L.S.D 5 %	2.89	0.5	0.4

* (C) Phosphorine ** (D) Mycorrhizal

Table (23) : The interaction effect of bio and mineral fertilizers on plant height number of tillers and dry weight after 45 days from planting soybean in 1993 season.

No	Treatment	Plant height cm	Number of tillers	Dry weight gm.
1	Control	36.82	1.50	5.45
2	22 P_2O_5 kg/Fed super phosphate	56.75	3.00	8.52
3	22 P_2O_5 kg/Fed Rock phosphate	43.50	2.25	7.10
4	Phosphorine 200 g./Fed (C)	44.10	2.25	6.62
5	Mycorrhizal 200 g/Fed (D)	42.45	2.25	7.17
6	100 g /Fed C. + 100 g/Fed (D)	43.50	2.50	6.75
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	58.85	3.25	8.45
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	48.15	3.00	7.175
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	42.37	3.50	6.97
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	60.70	3.50	8.27
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	50.77	3.00	7.30
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	43.10	3.00	6.42
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	46.80	3.50	7.20
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	43.12	3.00	6.72
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	41.00	3.00	6.72
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	44.42	4.00	7.22
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	42.55	3.00	6.42
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	41.30	3.00	6.20
	L.S.D 5 %	3.83	0.56	0.35

* (C) Phosphorine ** (D) Mycorrhizal

Table (24) : The interaction effect of bio and mineral fertilizers on plant height number of tillers, number of bods and dry weight after 75 days from planting soybean plants in 1992 season.

No	Treatment	Plant height cm	Number of tillers	Number of bods	Dry weight g
1	Control	54.42	2.00	12.25	15.44
2	22 P_2O_5 kg/Fed super phosphate	99.95	3.25	24.75	23.37
3	22 P_2O_5 kg/Fed Rock phosphate	76.20	2.75	18.50	16.98
4	Phosphorine 200 g./Fed (C)	78.12	2.50	19.50	16.16
5	Mycorrhizal 200 g/Fed (D)	80.90	2.50	14.50	16.23
6	100 g /Fed C. + 100 g/Fed (D)	80.47	2.75	18.25	15.95
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	99.00	3.75	25.00	24.56
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	90.37	3.50	21.25	20.06
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	84.67	2.50	19.50	16.20
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	105.52	4.00	26.00	24.90
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	91.35	3.25	22.00	21.80
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	80.12	2.50	19.75	16.80
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	87.72	5.00	22.25	20.08
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	83.17	3.00	20.00	16.52
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	80.37	3.00	17.00	13.36
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	88.10	4.00	23.00	19.41
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	84.25	3.00	17.75	15.62
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	79.17	2.50	14.00	13.29
	L.S.D 5 %	2.69	0.77	1.81	1.23

Table (25) : The interaction effect of bio and mineral fertilizers on plant height , number of tillers, number of bods and dry weight after 75 days from planting on soybean in 1993 season.

No	Treatment	Plant height cm	Number of tillers	Number of bods	Dry weight g
1	Control	56.82	2.00	11.00	14.58
2	22 P_2O_5 kg/Fed super phosphate	96.80	4.00	26.00	25.21
3	22 P_2O_5 kg/Fed Rock phosphate	79.45	3.00	19.00	19.74
4	Phosphorine 200 g./Fed (C)	79.72	2.50	19.00	18.12
5	Mycorrhizal 200 g/Fed (D)	81.10	2.75	17.00	17.61
6	100 g /Fed C. + 100 g/Fed (D)	80.45	2.75	18.50	17.22
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	100.97	4.25	26.25	25.49
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	91.95	3.00	19.25	22.24
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	84.32	3.00	17.25	18.27
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	100.32	5.00	26.25	26.87
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	91.12	3.00	20.5	22.78
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	80.92	3.00	17.75	20.50
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	88.10	4.00	21.50	22.50
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	84.62	3.50	18.25	18.18
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	80.65	3.00	14.25	15.56
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	88.30	4.00	19.75	22.27
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	85.32	3.00	15.25	19.10
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	79.65	3.00	13.50	16.16
	L.S.D 5 %	3.27	0.48	1.97	0.91

Table (26) : The interaction effect of bio and mineral fertilizers on (plant height , number of bods, number of seeds per plant) weight of 1000 seeds , seed and straw yield at harvesting stage on soybean 1992 season .

No	Treatment	Plant height cm	Number of bods / plant	Number of seeds plant	weight of seeds g./plant	weight of 1000 seeds g.	seeds yield kg/Fed.	straw yield kg/Fed.
1	Control	55.97	22.25	55.25	9.11	108.28	380	160
2	22 P_2O_5 kg/Fed super phosphate	89.80	40.75	113.00	18.64	190.52	1011	1070
3	22 P_2O_5 kg/Fed Rock phosphate	69.62	27.50	76.75	12.60	152.22	615	320
4	Phosphorine 200 g./Fed (C)	64.30	27.75	83.25	13.93	161.74	690	390
5	Mycorrhizal 200 g/Fed (D)	65.40	29.50	83.25	13.77	162.44	740	358
6	100 g /Fed C. + 100 g/Fed (D)	64.07	30.25	81.75	13.68	159.74	720	355
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	95.02	41.75	119.25	19.72	203.99	1070	1220
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	80.15	37.75	98.00	15.94	185.97	1030	770
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	74.45	33.50	91.75	15.13	167.94	680	430
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	96.42	44.50	122.50	20.26	215.45	1090	1270
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	81.65	40.00	111.25	18.23	189.95	1040	620
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	76.20	36.00	93.75	15.46	172.38	750	390
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	78.27	35.75	88.25	14.42	168.67	981	820
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	75.55	39.25	83.75	13.08	154.37	905	495
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	70.42	27.00	63.50	10.48	141.68	610	310
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	79.57	37.75	90.25	14.88	183.20	1000	870
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	76.55	31.75	84.25	13.89	172.16	990	520
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	72.12	26.26	72.00	11.87	150.88	600	320
	L.S.D 5 %	1.20	2.14	3.89	0.64	6.29	0.13	0.07

Table (27) : The interaction effect of bio and mineral fertilizers on (plant height, number of bods, number of seeds/plant, weight of seeds/per plant) weight of 1000 seeds, seed and straw yield at harvesting stage of soybean in 1993 season.

No	Treatment	Plant height cm	Number of bods / plant	Number of seeds plant	weight of seeds g./plant	weight of 1000 seeds g.	seeds yield kg/Fed.	straw yield kg/Fed.
1	Control	62.32	22.75	70.00	11.55	117.5	340	195
2	22 P_2O_5 kg/Fed super phosphate	94.82	45.25	131.50	21.77	209.30	1074	1050
3	22 P_2O_5 kg/Fed Rock phosphate	72.85	33.00	83.00	13.69	147.75	630	355
4	Phosphorine 200 g./Fed (C)	69.70	26.00	84.25	13.95	152.67	690	420
5	Mycorrhizal 200 g/Fed (D)	69.75	30.00	90.00	14.85	160.32	710	435
6	100 g /Fed C. + 100 g/Fed (D)	74.15	30.00	88.75	14.75	158.52	700	385
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	102.55	47.25	140.50	23.18	223.52	1275	1060
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	80.95	38.25	116.25	19.18	181.80	1050	640
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	75.05	35.00	100.50	16.58	167.00	630	373
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	104.52	48.75	145.25	23.96	232.02	1102	1130
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	82.50	41.50	119.75	19.75	191.00	1066	630
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	77.05	33.50	94.25	15.55	174.92	725	395
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	78.87	32.75	103.50	17.07	175.55	990	710
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	76.07	28.50	77.50	12.78	163.97	840	483
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	73.32	26.50	70.00	11.77	150.82	490	350
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	83.72	35.00	105.25	17.36	169.12	1006	750
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	80.57	31.00	80.75	13.30	165.75	900	620
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	76.35	28.50	74.25	12.22	158.50	525	370
	L.S.D 5 %	2.49	2.58	4.04	0.67	5.34	0.14	0.05

These data were in agreement with those obtained by Pawell and Daniel (1978).

4.2.1.8 Soybean yield :

Data in Tables (26 and 27) show plant yield of both seeds and straw as influenced by the different fertilization treatments.

The plant yield of seeds in kg/Fed. increased significantly due to fertilization with the mineral and biofertilizers. The effect of super phosphate on the yield was more obvious than that of the rock phosphate in both seasons of cultivation. Also, ***Mycorrhizal*** produced a yield of seeds higher than that produced by phosphorine.

The fertilization treatment composed of 16.5 kg P_2O_5/Fed. as super phosphate combined with 50 g. of ***Mycorrhizal*** produced the highest seed yield whereas the treatment composed of the same level of super phosphate combined with 50 g. of ***phosphorine*** was in the second order. The other combinations between the mineral fertilizers and the biofertilizers produced seed yield comparatively lower than the abovementioned treatments. However, it is worthy to mention that the combinations between super phosphate and the biofertilizers resulted in seed yield higher than that produced by the combinations of rock phosphate with the biofertilizers. These results are in agreement with those obtained by Tisdale ***et al*** (1975) who found that inoculation with the phosphobacterium increased yield of legumes. Gaydou ***et al*** (1983) went almost to similar results.

Regarding the plant yield of straw, data show that straw yield in both seasons of cultivation was highest upon fertilization with a combination of super phosphate with ***Mycorrhizal*** at levels of 16.5 kg P_2O_5/Fed. and 50 g. of the biofertilizer, respectively. The combination between the same level of super phosphate with 50 g. of ***phosphorine*** gave a compartively lower straw yield, yet, this yield exceeded that produced by any other combination between the mineral fertilizer and the biofertilizers. Super phosphate gave a higher yield of straw than that obtained due to fertilization with the rock phosphate. Also, the different combinations of super phosphate with the biofertilizers at any given rate gave higher yield of straw than the yield produced by the corresponding combinations between rock phosphate and the biofertilizers.

The obtained results and the given explanations are in close agreement with many of the previous studies e.g Tinker (1978); Harley and Smith (1983); Gianinazzi and Gianinazzi (1989).

4.2.2. Concentration and uptake of N, P and K by soybean plant as influenced by phosphatic fertilization :

4.2.2.1. Concentration of N, P and K in soybean plant :

Regarding concentration of N, P and K, Tables (28, 29, 30 and 31) reveal that all the phosphatic fertilization treatments increased significantly the concentration of N, P and K after 45 and 75 days of cultivation. The recommended rate of the super phosphate resulted in higher concentrations of N, P and K than those produced due to fertilization with rock phosphate or biofertilizers. Application of three fourths of the recommended level of super phosphate combined with 50 g. of ***Mycorrhizal*** resulted in the highest concentrations of the abovementioned three elements. Slightly lower concentrations of these elements were found in the plants upon application of the same level of super phosphate combined with50 g. of phosphorine. The combination between rock phosphate and the biofertilizers gave relatively lower concentrations of N, P and K in plant shoots.It is worthy to indicate that concentration of the studied elements in plant shoots, although were relatively higher in season 1993 than in season 1992, yet the effect of the mineral and biofertilizers on plant concentrations of these elements was higher in the second season of cultivation than the first ones.

Data in Table (32, 33, 34 and 35) show that concentrations of N, P and K in soybean yield components (seeds and straw) increased significantly by the different fertilization treatment , the increases in concentration of these elements upon fertilization with super phosphate were higher than the corresponding increases upon fertilization with either of rock phosphate, ***phosphorine*** or ***Mycorrhizal*** alone. The plants inoculated with ***phosphorine*** or ***Mycorrhizal*** in presence of a source of available P (super phosphate or rock phosphate) contained higher concentration of the fertilizer elements than the other inoculated alone. Concentration of the three elements in seeds and straw seemed to be controlled by varing the amount of the mineral and biofertilizers. In this concern, the interaction effect of super phosphate (added at 75% of its recommended rate) with ***Mycorrhizal*** added at rate of (50 g./Fed.) was the highest followed by that of super phosphate (at the same abovementioned rate) with ***phosphorine*** at a rate of (50 g./Fed.)

It is obvious from data that the super phosphate - biofertilizers interactions were more effective on N, P and K concentrations than the rock phosphate - biofertilizer ones. These results are in accordance with those obtained by Baz ***et al*** (1984).

Comparison between concentrations of N, P and K in both yield components (seeds and straw) of the two seasons of the experiments indicates that all these elements were found in relatively lower concentrations in the first season than the second one. However, it could be noticed that the fertilization treatments showed trends in the second season similar to those shown in the first ones.

Generally, the results are in agreement with that reported by Hilal ***et al.*** (1975); Young ***et al.***(1986) and Abd-El- Maksoud ***et al.*** (1988).

4.2.2.2. Uptake of N, P and K by soybean plant :

Shoots uptake of N, P and K due to the different fertilization treatments is shown in Tables (28, 29, 30 and 31). All the fertilization treatments increased significantly shoots uptake of N, P and K. The super phosphate seemed to be more effective on uptake of N, P and K than the rock phosphate, ***phosphorine*** or ***Mycorrhizal.***

Results show also that ***Mycorrhizal*** plants had higher shoot dry matter yield, P concentrations and concequently P uptake than the plants fertilized with ***phosphorine*** or non- ***Mycorrhizal*** plants grown on without suplemental phosphorus.

Data reveal also that the uptake of N, P and K was higher upon fertilization with 16.5 kg P_2O_5/Fed. combined with 50 g/Fed. ***Mycorrhizal.***

The different combinations between the super phosphate and biofertilizers resulted in higher uptake of the three elements than that taken up upon application of corresponding rates of rock phosphate with the biofertilizers.

The interaction effect between the mineral and biofertilizers seemed to stimulate plant growth as a whole and consequently a higher dry weight of the shoots was obtained which, in turn, increased the uptake of the studied elements obviously.

The increase in shoots dry weight besides of the relative increase in N, P and K concentrations of soybean plant grown in 1993 over that grown in

Table (28) : The interaction effect of bio and mineral fertilizers on dry weight of soybean plant, concentration and uptake of N, P and K after 45 day from planting 1992 season.

No	Treatment	Dry weight g /per plant	1992					
			Nutrients concentration %			Nutrients uptake mg per/plant		
			N	P	K	N	P	K
1	Control	5.05	3.350	0.33	1.31	166.75	16.65	66.53
2	22 P_2O_5 kg/Fed super phosphate	8.30	6.35	1.07	2.67	526.75	79.41	222.04
3	22 P_2O_5 kg/Fed Rock phosphate	6.925	5.23	0.86	1.56	362.50	59.92	108.66
4	Phosphorine 200 g./Fed (C)	6.97	5.61	0.94	1.87	391.25	64.34	130.80
5	Mycorrhizal 200 g/Fed (D)	7.10	5.97	0.98	1.97	417.50	69.46	140.22
6	100 g /Fed C. + 100 g/Fed (D)	6.67	5.68	0.94	1.88	379.25	63.10	127.29
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	8.37	7.06	1.17	2.71	591.50	97.99	227.38
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	7.32	6.65	1.01	2.54	489.75	74.33	186.42
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	6.95	5.57	0.96	2.24	387.25	67.24	156.03
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	8.62	7.17	1.22	2.75	619.00	105.82	235.29
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	7.40	6.13	1.10	2.58	454.00	81.59	191.29
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	6.37	5.61	0.99	2.34	357.00	63.39	149.31
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	7.17	5.89	1.08	2.22	422.50	78.01	159.32
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	6.62	5.725	0.96	2.115	379.50	63.64	140.09
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	6.47	5.49	0.89	2.01	350.75	59.65	130.45
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	6.87	6.05	1.12	2.37	415.50	77.34	163.51
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	6.50	5.83	1.05	2.21	382.50	68.57	142.42
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	6.45	5.61	0.97	2.07	361.75	62.90	133.48
	L.S.D 5 %	0.4	0.24	0.03	0.05	7.20	1.84	2.55

Table (29) : The interaction effect of bio and mineral fertilizers on dry weight of soybean plant, concentration and uptake of N, P and K after 45 days from planting 1993 season.

No	Treatment	Dry weight g /per plant	1993					
			Nutrients concentration %			Nutrients uptake mg per/plant		
			N	P	K	N	P	K
1	Control	5.45	3.68	0.41	1.37	201.00	22.37	74.91
2	22 P_2O_5 kg/Fed super phosphate	8.52	6.85	1.15	2.71	583.75	98.07	231.45
3	22 P_2O_5 kg/Fed Rock phosphate	7.100	5.35	0.96	1.73	379.75	68.50	124.66
4	Phosphorine 200 g./Fed (C)	6.62	5.62	1.04	1.97	372.25	69.02	126.72
5	Mycorrhizal 200 g/Fed (D)	7.17	5.78	1.08	2.09	415.25	77.47	150.12
6	100 g /Fed C. + 100 g/Fed (D)	6.75	5.55	1.06	1.96	373.75	72.01	132.72
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	8.45	7.11	1.27	2.75	621.50	111.12	239.10
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	7.17	6.71	1.11	2.55	482.00	80.01	183.31
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	6.97	5.65	1.06	2.27	394.25	71.96	158.50
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	8.27	7.23	1.32	2.805	698.50	124.14	262.25
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	7.30	6.25	1.17	2.62	456.00	85.76	191.62
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	6.42	5.62	1.09	2.38	362.00	70.37	153.25
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	7.20	5.90	1.18	2.28	424.50	85.52	164.50
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	6.72	5.77	1.06	2.17	380.75	71.33	146.29
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	6.72	5.55	1.04	2.10	373.25	70.44	141.54
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	7.22	6.09	1.22	2.48	435.75	88.68	179.55
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	6.42	6.00	1.13	2.25	385.50	72.73	144.87
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	6.20	5.83	1.06	2.13	361.75	66.07	132.38
	L.S.D 5 %	0.35	0.23	0.04	0.03	7.51	1.26	2.28

Table (30) : The interaction effect of bio and mineral fertilizers on dry weight soybean plant, concentration and uptake of N, P and K after 75 days from planting 1992 season.

No	Treatment	Dry weight g /per plant	1992					
			Nutrients concentration %			Nutrients uptake mg per/plant		
			N	P	K	N	P	K
1	Control	15.44	3.11	0.25	1.26	473.00	39.36	174.71
2	22 P_2O_5 kg/Fed super phosphate	23.73	6.18	0.91	2.47	1446.83	212.68	503.58
3	22 P_2O_5 kg/Fed Rock phosphate	16.98	5.12	0.61	1.40	870.49	104.47	238.66
4	Phosphorine 200 g./Fed (C)	16.16	5.41	0.74	1.70	875.00	119.92	275.45
5	Mycorrhizal 200 g/Fed (D)	16.23	5.67	0.76	1.77	921.36	123.77	285.67
6	100 g /Fed C. + 100 g/Fed (D)	15.95	5.50	0.73	1.71	877.42	129.72	273.20
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	24.56	6.72	0.93	2.51	1651.68	228.90	617.74
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	20.06	6.37	0.81	2.24	1279.96	163.65	450.19
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	16.20	5.37	0.79	2.14	872.22	127.94	347.53
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	24.90	6.98	0.97	2.57	1740.35	242.12	641.14
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	21.80	5.93	0.87	2.29	1286.05	189.97	501.08
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	16.80	5.37	0.80	2.23	904.05	134.43	374.67
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	20.08	6.68	0.83	2.14	1142.43	164.15	430.72
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	16.52	5.52	0.74	2.02	912.83	123.32	334.45
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	13.36	5.30	0.66	1.88	710.47	88.21	219.70
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	19.41	5.81	0.87	2.26	1128.31	169.77	439.62
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	15.66	5.63	0.76	2.12	881.07	119.82	333.49
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	13.29	5.40	0.67	1.96	719.88	89.80	261.23
	L.S.D 5 %		0.2	0.03	0.03	19.17	3.97	15.57

Table (31) : The interaction effect of bio and mineral fertilizers on dry weight soybean plant, concentration and uptake of N, P and K after 75 days from planting 1993 season.

No	Treatment	Dry weight g /per plant	1993					
			Nutrients concentration %			Nutrients uptake mg per/plant		
			N	P	K	N	P	K
1	Control	14.58	3.53	0.23	1.31	515.52	33.92	191.93
2	22 P_2O_5 kg/Fed super phosphate	25.21	6.74	0.91	2.51	1695.00	232.95	634.05
3	22 P_2O_5 kg/Fed Rock phosphate	19.74	5.23	0.65	1.63	1034.15	129.29	322.72
4	Phosphorine 200 g./Fed (C)	18.12	5.47	0.73	1.80	992.42	133.84	327.17
5	Mycorrhizal 200 g/Fed (D)	17.61	5.65	0.77	1.80	995.75	136.10	324.98
6	100 g /Fed C. + 100 g/Fed (D)	17.22	5.31	0.72	1.74	915.26	124.41	275.00
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	25.49	6.82	0.97	2.56	1648.86	247.25	646.45
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	22.42	6.50	0.91	2.35	1445.5	202.18	523.87
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	18.27	5.48	0.76	2.16	1002.30	139.77	395.55
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	26.87	7.08	1.02	2.63	1905.01	274.70	706.52
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	22.78	6.04	0.92	2.42	1375.83	211.21	552.45
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	20.50	5.45	0.79	2.28	1117.57	163.03	468.49
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	22.50	5.77	0.96	2.18	1299.79	211.37	496.54
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	18.18	5.58	0.76	2.06	1015.89	139.09	375.37
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	15.56	5.25	0.69	1.91	813.57	108.59	298.06
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	22.27	5.91	0.97	2.30	1318.37	217.75	512.35
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	19.10	5.78	0.85	2.15	1105.36	163.42	411.57
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	16.16	5.57	0.77	1.98	900.91	125.20	313.70
	L.S.D 5 %		0.21	0.03	0.03	13.98	2.35	7.02

Table (32) : The interaction effect of bio and mineral fertilizers on seed yield, concentration and uptake of N, P and K by soybean seeds (1992) season.

No	Treatment	Seed yield Ton/Fed	1992					
			Nutrients concentration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	0.38	4.44	0.19	1.18	17.76	0.75	4.55
2	22 P_2O_5 kg/Fed super phosphate	1.01	6.08	0.59	2.26	61.16	6.15	22.90
3	22 P_2O_5 kg/Fed Rock phosphate	0.61	5.03	0.41	1.27	30.96	2.55	6.55
4	Phosphorine 200 g./Fed (C)	0.69	5.27	0.45	1.54	36.38	3.13	9.88
5	Mycorrhizal 200 g/Fed (D)	0.74	5.48	0.47	1.67	39.39	3.54	10.79
6	100 g /Fed C. + 100 g/Fed (D)	0.72	5.13	0.44	1.61	38.55	3.19	11.80
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	1.07	6.45	0.61	2.31	69.29	6.60	24.79
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	1.03	6.18	0.50	2.14	64.01	5.18	22.61
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	0.68	5.22	0.47	2.01	35.67	3.24	14.64
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	1.09	6.55	0.64	2.37	71.39	7.02	25.99
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	1.04	5.73	0.55	2.22	59.66	5.91	23.07
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	0.75	5.22	0.51	2.13	39.18	3.85	13.82
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	0.98	5.48	0.56	2.08	54.10	5.56	20.51
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	0.90	5.32	0.52	1.91	48.18	4.73	17.29
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	0.61	5.09	0.48	1.68	49.25	2.97	12.75
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	1.00	5.61	0.59	2.16	56.10	5.95	21.65
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	0.99	5.43	0.55	1.93	53.82	5.49	19.30
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.60	5.20	0.50	1.76	31.20	3.04	10.55
	L.S.D 5 %	0.13	0.21	0.03	0.02	12.51	0.34	2.84

Table (33) : The interaction effect of bio and mineral fertilizers on seed yield, concentration and uptake of N, P and K by soybean seeds (1993) season.

No	Treatment	Seed yield Ton/Fed	1992					
			Nutrients concentration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	0.34	4.69	0.22	1.22	15.95	0.76	4.98
2	22 P_2O_5 kg/Fed super phosphate	1.07	6.52	0.60	2.31	70.07	6.49	24.84
3	22 P_2O_5 kg/Fed Rock phosphate	0.63	5.06	0.45	1.46	31.90	2.87	9.35
4	Phosphorine 200 g./Fed (C)	0.69	5.27	0.47	1.60	36.29	3.01	11.05
5	Mycorrhizal 200 g/Fed (D)	0.71	5.45	0.51	1.64	38.71	3.66	11.52
6	100 g /Fed C. + 100 g/Fed (D)	0.70	5.11	0.47	1.52	35.80	5.13	10.29
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	1.27	6.61	0.64	2.36	71.80	7.00	29.68
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	1.05	6.31	0.54	2.18	66.20	5.71	21.30
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	0.63	5.28	0.50	2.11	33.44	3.17	17.70
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	1.10	6.75	0.68	2.52	74.37	7.54	24.39
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	1.06	5.86	0.63	2.33	68.48	6.78	22.56
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	0.72	5.26	0.57	2.20	38.15	4.13	15.93
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	0.99	5.60	0.52	2.10	55.43	5.19	21.05
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	0.84	5.38	0.47	1.92	47.44	4.08	13.98
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	0.49	5.06	0.45	1.70	24.83	2.23	8.32
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	1.00	5.71	0.60	2.20	57.53	6.08	22.15
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	0.90	5.58	0.55	1.98	50.26	4.99	17.83
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.52	5.37	0.51	1.80	28.37	2.71	9.50
	L.S.D 5 %	0.14	0.20	0.02	0.03	4.82	1.19	4.78

Table (34) : The interaction effect of bio and mineral fertilizers on straw yield, concentration and uptake of N, P and K by soybean straw (1992) season.

No	Treatment	Straw yield Ton/Fed	1992					
			Nutrients concentration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	0.16	0.33	0.02	0.41	0.55	0.03	0.69
2	22 P_2O_5 kg/Fed super phosphate	1.07	0.50	0.06	0.67	5.41	0.71	7.18
3	22 P_2O_5 kg/Fed Rock phosphate	0.32	0.44	0.05	0.45	1.44	0.19	1.47
4	Phosphorine 200 g./Fed (C)	0.39	0.46	0.07	0.53	1.81	0.28	2.08
5	Mycorrhizal 200 g/Fed (D)	0.35	0.48	0.08	0.57	1.80	0.28	2.04
6	100 g /Fed C. + 100 g/Fed (D)	0.35	0.44	0.07	0.54	2.47	0.26	1.92
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	1.22	0.54	0.08	0.70	6.53	1.01	8.60
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	0.77	0.46	0.08	0.63	3.60	0.59	4.91
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	0.43	0.43	0.07	0.58	1.86	0.32	2.51
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	1.27	0.58	0.08	0.74	7.39	1.10	9.57
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	0.62	0.52	0.08	0.67	4.35	0.51	4.17
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	0.39	0.46	0.07	0.62	1.83	0.30	2.46
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	0.82	0.48	0.07	0.64	3.45	0.63	5.24
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	0.49	0.45	0.07	0.58	2.24	0.36	2.89
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	0.31	0.42	0.07	0.55	1.33	0.22	1.74
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.87	0.50	0.08	0.65	4.42	0.70	5.73
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	0.52	0.47	0.07	0.61	2.49	0.41	3.22
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.32	0.44	0.07	0.57	1.41	0.25	1.84
	L.S.D 5 %	0.07	0.02	0.00	0.03	1.11	0.05	0.49

Table (35) : The interaction effect of bio and mineral fertilizers on seed yield, concentration and uptake of N, P and K by soybean straw (1993) season.

No	Treatment	Straw yield Ton/Fed	1992					
			Nutrients concentration %			Nutrients uptake kg/Fed.		
			N	P	K	N	P	K
1	Control	0.19	0.35	0.02	0.45	0.68	0.45	0.88
2	22 P_2O_5 kg/Fed super phosphate	1.05	0.54	0.07	0.70	5.72	0.72	7.39
3	22 P_2O_5 kg/Fed Rock phosphate	0.35	0.48	0.06	0.49	1.71	0.22	1.75
4	Phosphorine 200 g./Fed (C)	0.42	0.47	0.07	0.54	1.99	0.31	2.27
5	Mycorrhizal 200 g/Fed (D)	0.43	0.51	0.08	0.56	2.23	0.35	2.44
6	100 g /Fed C. + 100 g/Fed (D)	0.38	0.46	0.08	0.52	1.79	0.30	2.00
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	1.06	0.58	0.08	0.74	6.27	0.92	7.89
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	0.64	0.54	0.08	0.67	3.49	0.53	4.31
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	0.37	0.49	0.08	0.62	1.84	0.29	2.32
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	1.13	0.62	0.09	0.78	7.09	1.03	8.86
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	0.63	0.58	0.08	0.71	3.68	0.55	4.50
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	0.39	0.54	0.08	0.66	2.32	0.32	2.62
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	0.71	0.52	0.08	0.68	3.73	0.59	4.86
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	0.48	0.48	0.08	0.61	2.34	0.38	2.96
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	0.35	0.44	0.07	0.59	1.55	0.26	2.07
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.75	0.55	0.08	0.69	4.16	0.62	5.22
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	0.62	0.51	0.08	0.65	3.19	0.49	4.06
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.37	0.47	0.07	0.61	1.76	0.27	2.27
	L.S.D 5 %	0.49	0.02	0.00	0.02	0.24	0.02	0.28

1992 resulted in higher uptake of these elements in the second season of the experiment than the first one.

Data in Tables (32, 33, 34 and 35) illustrate the effect of the mineral fertilizers (super phosphate and rock phosphate), the biofertilizers (***Phosphorine*** and ***Mycorrhizal***) as well as the interaction between the mineral fertilizers and biofertilizers on N, P and K uptake by soybean seeds and straw.

The uptake of the three elements by both straw and seeds were higher upon inoculation with 50g ***Mycorrhizal*** per Fed. in presence of 75% of the recommended rate of super phosphate. Relatively lower uptake of these elements was recorded upon fertilization with the same level of super phosphate and inoculation with 50 g. of ***Phosphorine***.

Inoculation with ***Phosphorine*** or ***Mycorrhizal*** with the rock phosphate at any rate resulted in lower uptake of N, P and K than that achieved due to inoculation with the corresponding rate of the biofertilizers with the super phosphate.

Inoculation with ***Phosphorine*** or ***Mycorrhizal*** alone resulted in lower uptake values of N, P and K than those obtained upon fertilization with the super phosphate only which was slightly higher than those upon fertilization with rock phosphate only. From the forementioned result, it could be concluded that the mineral phosphate - inoculum interactions were often much better in creating plant responses than the application of either the mineral or the biofertilizers alone. Such conclusion concentrates the light on the importance of biofertilizers as a source of enriching soil and concequently with essential nutrients besides of the economical importance of biofertilizers in reducing costs of fertilization. Moreover, the negative ecological effect of the biofertilizers can be neglected as compared with pollution of the environment caused by using mineral phosphate fertilizers.

Genarelly, the results are in agreement with Sineh ***et al.*** (1972) who found that the nitrogen uptake of two soybean varieties significantly increased by phosphorus application. They are also in agreement with those obtained by Besado ***et al.*** (1991); Yassen (1992) and Abo-Serie (1992).

4.2.3. Chemical composition of soybean seeds:

The soybean seeds (Clark variety) were subjected to chemical analysis. Data in Tables (36 and 37) indicate the interaction effect of biofertilizers and mineral fertilizers on the constituents of soybean seeds (g/100g on dry weight basis) during 1992/1993 seasons.

The obtained results illustrate that there are slight differences between moisture, crude protein, crude fat, total carbohydrates and ash contents of soybean seed for both 1992/1993 seasons.

From the obtained results illustrated in Tables (36 and 37), it could be noticed that the highest values of crude protein content of soybean seeds i.e. 42.46, 42.84% were achieved with the treatments that was consisted of 16.5 P_2O_5 kg/Fed super, 1/4 the suggested dose of ***Phosphorine*** that consisted of 16.5 kg P_2O_5/Fed super + 1/4 the suggested dose of ***Mycorrhizal***. On the other hand, the lowest valuesi.e. 34.28, 34.04% were acquired with the treatments of 22 kg P_2O_5/Fed Rock phosphate and 5.5 kg P_2O_5/Fed Rock +3/4 ***Phosphorine***, respectively.

Also, the obtained data indicate that the treatment of 16.5kg P_2O_5/Fed super + 1/4 the ***Phosphorine*** dose (50g) caused the highest value i.e. 22.11% of crude fat content while the control treatment occurred the lowest value i.e. 19.80%.

Table (36) : The interaction effect of biofertilizers and mineral fertilizers on chemical constituents of soybean seeds (g/100g on dry weight basis) 1992 season.

No	Treatment	Season 1992							
		Moisture %	Crude protein %	Crude fat %	Total * carbohydrate %	* Ash %	Crude protein kg/Fed.	crude fat kg/Fed.	Total carbohydrate kg/Fed.
1	Control	7.01	35.27	19.80	36.93	6.22	135.78	76.23	142.18
2	22 P_2O_5 kg/Fed super phosphate	8.57	41.61	21.40	34.13	3.06	420.67	216.35	345.05
3	22 P_2O_5 kg/Fed Rock phosphate	8.16	34.28	21.14	38.88	4.81	210.82	130.01	239.11
4	Phosphorine 200 g./Fed (C)	8.22	35.91	20.72	37.42	5.06	247.77	142.96	258.19
5	Mycorrhizal 200 g/Fed (D)	8.27	37.38	20.82	35.03	5.01	278.48	155.10	260.97
6	100 g /Fed C. + 100 g/Fed (D)	8.35	36.22	21.22	35.12	5.07	262.59	153.84	254.62
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	8.61	42.46	22.11	31.41	3.20	456.02	237.46	337.34
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	8.51	42.26	21.35	30.91	4.16	436.96	220.75	319.60
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	8.25	35.58	21.41	36.99	4.19	243.01	146.23	252.64
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	8.70	41.63	21.79	32.82	2.76	453.76	237.51	357.73
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	8.50	39.18	21.50	34.01	3.95	407.47	223.60	353.70
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	8.23	35.58	21.03	37.85	3.99	266.85	157.72	283.87
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	8.13	37.32	21.50	34.94	4.37	367.97	211.99	344.50
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	8.13	36.22	21.09	36.43	4.56	327.79	190.86	329.69
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	8.10	34.41	21.07	37.18	4.62	209.90	128.52	226.79
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	8.29	38.25	21.65	34.47	4.19	383.26	216.93	345.38
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	8.28	37.04	21.12	35.81	4.38	366.69	209.08	354.51
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	8.20	35.40	21.07	36.35	4.48	212.40	126.42	218.10

* This value was calculated on dry weight basis

Table (37) : The interaction effect of biofertilizers and mineral fertilizers on chemical constituents of soybean seeds (g/100g on dry weight basis) 1993 season.

No	Treatment	Season 1993							
		Moisture %	Crude protein %	Crude fat %	Total * carbohydrate %	* Ash %	Crude protein kg/Fed.	crude fat kg/Fed.	Total carbohydrate kg/Fed.
1	Control	6.64	34.81	19.35	38.51	5.53	118.35	65.79	130.93
2	22 P_2O_5 kg/Fed super phosphate	7.85	42.08	21.45	33.41	2.97	451.93	230.37	358.82
3	22 P_2O_5 kg/Fed Rock phosphate	7.34	34.13	20.53	38.76	3.53	215.01	129.33	244.18
4	Phosphorine 200 g./Fed (C)	7.43	35.60	20.60	38.38	3.86	245.64	142.14	264.82
5	Mycorrhizal 200 g/Fed (D)	7.51	36.81	20.58	37.19	3.80	261.35	146.11	264.04
6	100 g /Fed C. + 100 g/Fed (D)	7.50	34.54	20.62	39.30	3.83	241.78	144.34	275.10
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	7.95	42.71	21.18	31.23	2.91	544.55	270.04	398.18
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	7.85	41.75	20.87	31.09	4.08	438.37	219.13	326.44
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	7.02	35.53	20.62	38.68	4.09	223.83	129.90	243.68
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	8.55	42.84	21.54	32.40	2.71	472.09	237.37	357.04
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	7.75	39.70	20.97	33.77	3.90	423.20	223.54	359.98
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	7.06	35.37	20.60	38.74	3.92	256.43	149.35	280.86
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	7.16	37.68	20.83	35.81	4.15	373.03	206.21	354.51
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	7.15	36.25	20.49	38.13	3.23	304.50	172.11	320.29
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	7.10	34.04	20.45	39.74	3.34	166.79	100.20	194.72
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	7.20	38.51	20.85	35.06	4.10	387.41	209.75	352.70
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	7.18	37.61	20.57	35.30	4.29	338.49	185.13	317.70
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	7.16	36.56	20.57	38.02	3.68	191.94	107.99	199.60

* This value was calculated on dry weight basis

Table (38) : The interaction effect of biofertilizers and mineral fertilizers on reducing and non-reducing sugars % of soybean seeds, 1993 season.

	Treatment	Total soluble sugars %	Reducing sugars %	non-reducing sogars %
1	Control	5.310	1.160	4.150
2	22 P_2O_5 kg/Fed super phosphate	5.960	1.210	4.75
3	22 P_2O_5 kg/Fed Rock phosphate	5.820	1.170	4.650
4	Phosphorine 200 g./Fed (C)	5.635	1.170	4.465
5	Mycorrhizal 200 g/Fed (D)	5.630	1.175	4.455
6	100 g /Fed C. + 100 g/Fed (D)	5.620	1.170	4.450
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	5.965	1.215	4.750
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	5.910	1.210	4.700
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	5.880	1.200	4.680
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	5.985	1.225	4.760
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	5.995	1.210	4.740
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	5.940	1.203	4.730
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	5.893	1.200	4.690
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	5.860	1.200	4.660
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	5.840	1.200	4.640
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	5.905	1.205	4.700
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	5.882	1.202	4.680
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	5.865	1.200	4.665

These values were calculated on dry weight basis

Total carbohydrates content of soybean seeds ranged between (30.91/38.88%) for 1992 season and (31.09/38.76%) for 1993 as shown in Table (36). Ash content varied from (2.76 and 6.22%) to (2.71 to 5.53%) for the abovementioned seasons.

Generally, the obtained results are in agreement with those obtained by Foda *et al* (1984) and Ragab (1994) during their work on different varieties of soybean seeds.

It is worthy to mentione that, according to the obtained results, it could be concluded that there is an opposite relationship between the sum of protein and fat content and the total carbohydrates content of soybean seeds. In other words, the treatments which caused an increment in protein and fat content of soybean seed, were accompanied with decrements in the total carbohydrates content in comparison with control treatment. This observation may be due to the inversion of some carbohydrates content to protein and fat molecules during the metabolism at the ripening stage.

Results in Table (38) indicate the interaction effect of biofertilizers and mineral fertilizers on reducing and non-reducing sugars of soybean seed.

From the obtained results in Table (38), it is clear that the different treatments of mineral and biofertilizers caused a very slight change in total soluble sugars in comparison with control treatment. Also, the obtained data illustrate that a very minute changes had occurred in reducing and non-reducing sugars between different treatments.

4.2.3.1. Separation and identification of the fatty acids composition of soybean oil

Results tabulated in Table (39) and illustrated in the figures (1 to 10) showed the effect of biofertilizers and mineral fertilizers on the fatty acid

Table (39) : The interaction effect of bio and mineral fertilizers on fatty acid composition of soybean crude oil (1993) season.

No	Treatment	Identified fatty acids %								
		Saturated acids				Unsaturated acids				
		Myristic $C_{14:0}$	Palmitic $C_{16:0}$	Stearic $C_{18:0}$	*T.S %	Oleic $C_{18:1}$	Linoleic $C_{18:2}$	Linolenic $C_{18:3}$	**TUS %	TUS : TS
1	Control	0.342	16.38	1.82	18.54	28.49	45.06	7.71	81.26	4.38
2	22 P_2O_5 /Fed super Ph.	0.185	10.17	3.87	14.22	26.60	48.19	9.97	84.76	5.96
3	22 P_2O_5 /Fed rock Ph.	0.208	11.682	2.919	14.80	27.68	50.27	6.68	84.63	5.71
4	***Phosphorine (C)***	0.220	10.79	2.140	13.15	32.88	43.96	9.95	86.79	6.60
5	***Mycorrhizal (D)***	0.011	11.58	1.53	13.12	24.71	51.73	9.86	86.30	6.58
6	16.5 P_2O_5 /Fed super Ph + 50 C	0.095	10.06	2.65	12.80	24.65	52.90	8.86	86.41	6.75
7	11 P_2O_5 /Fed super Ph + 100 C	0.078	11.68	3.57	15.32	23.33	53.84	7.24	84.41	5.51
8	16.5 P_2O_5 /Fed super Ph + 50 D	0.069	12.31	2.19	14.56	26.11	50.96	8.31	85.38	5.86
9	16.5 P_2O_5 /Fed rock Ph + 50 C	0.194	11.599	1.545	13.33	27.42	51.70	7.49	86.61	6.49
10	16.5 P_2O_5 /Fed super Ph + 50 D	0.110	11.05	1.44	12.60	27.72	52.20	7.44	87.36	6.93

(c) ***Phosphorine*** (D) *VA Mycorrhizal*

* T.S. : Saturated fatty acids

** T.U.S. : Total unsaturated fatty acids.

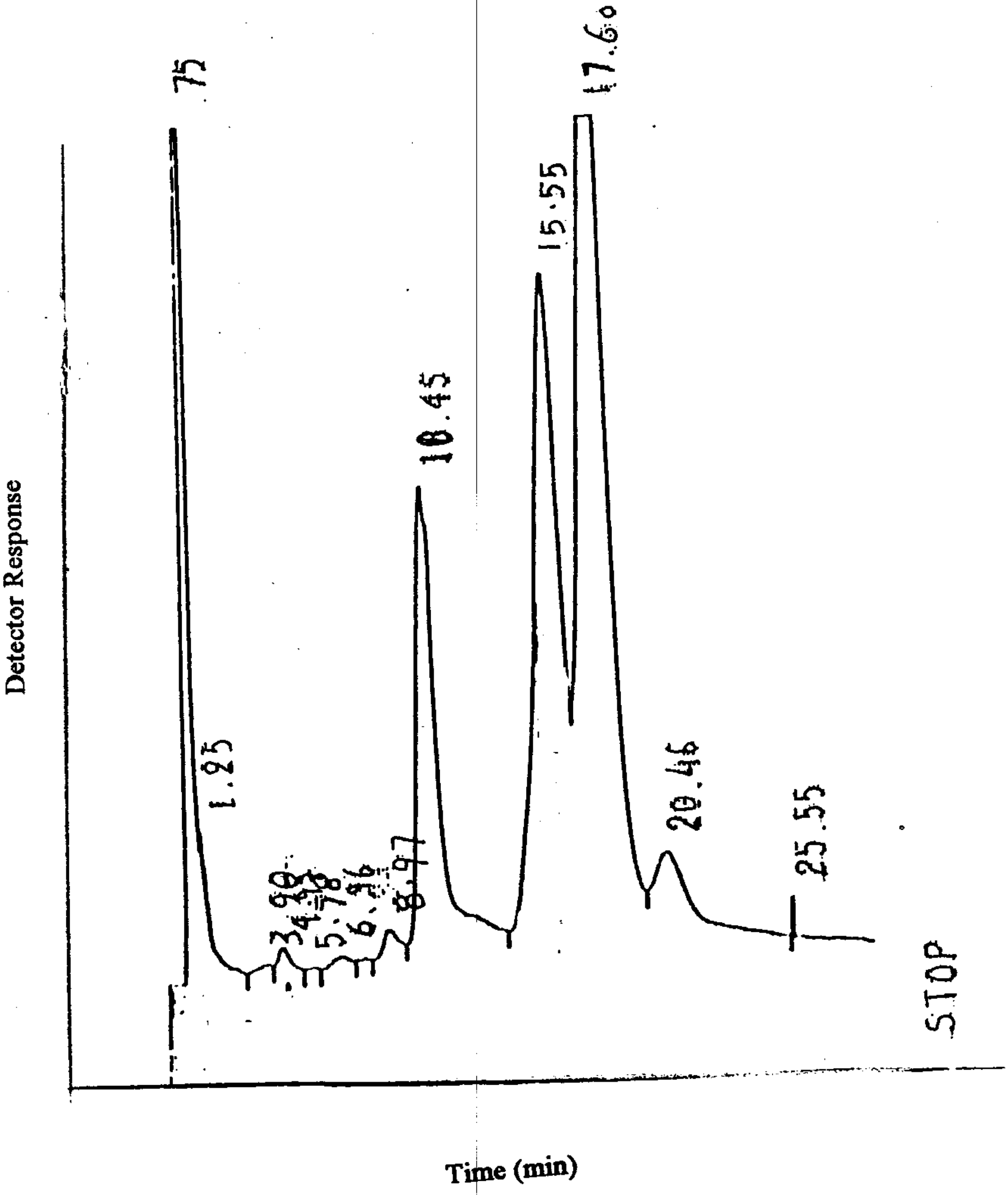

Fig (1) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) control

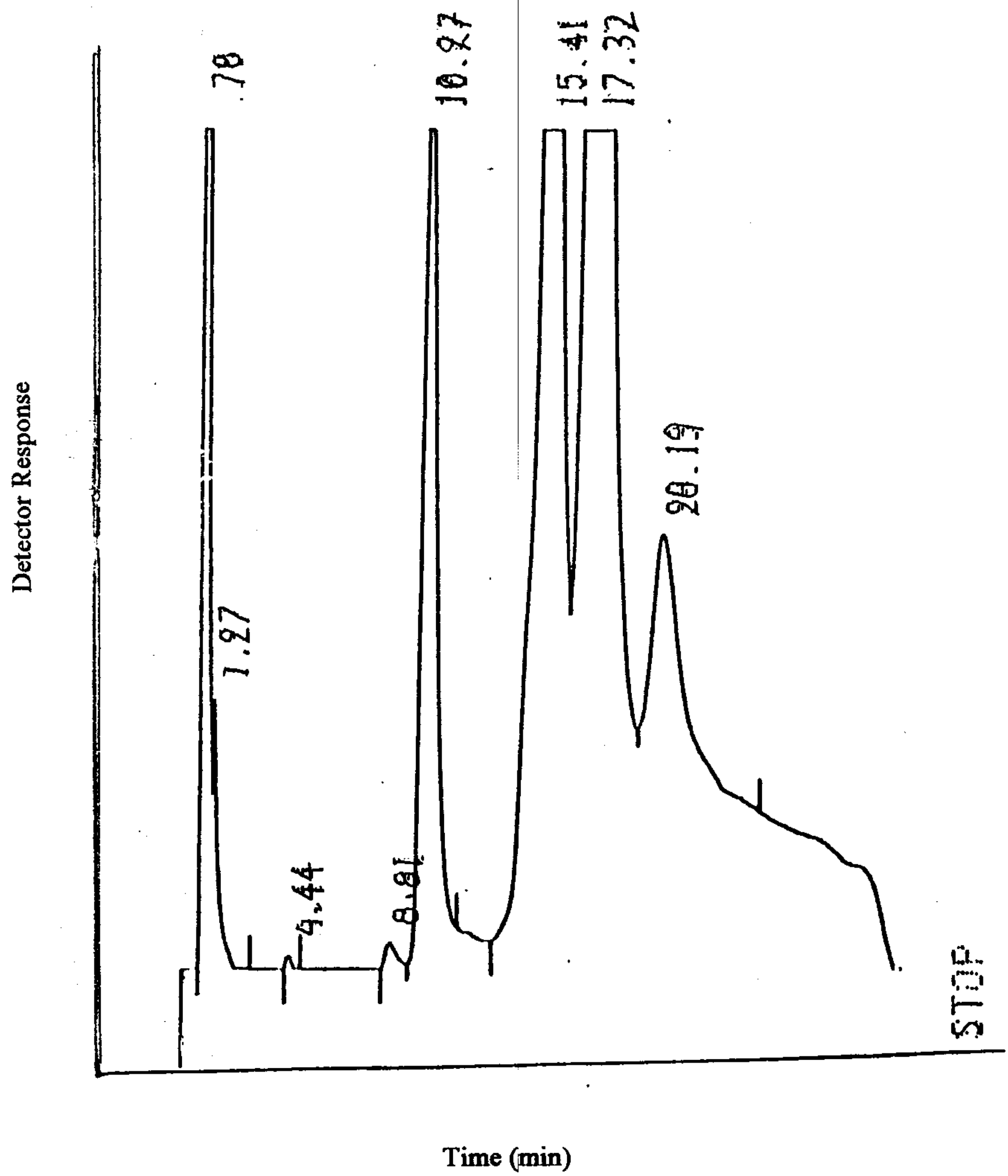

Fig (2) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (22 kg P_2O_5/Fed super phosphate, recommended rate)

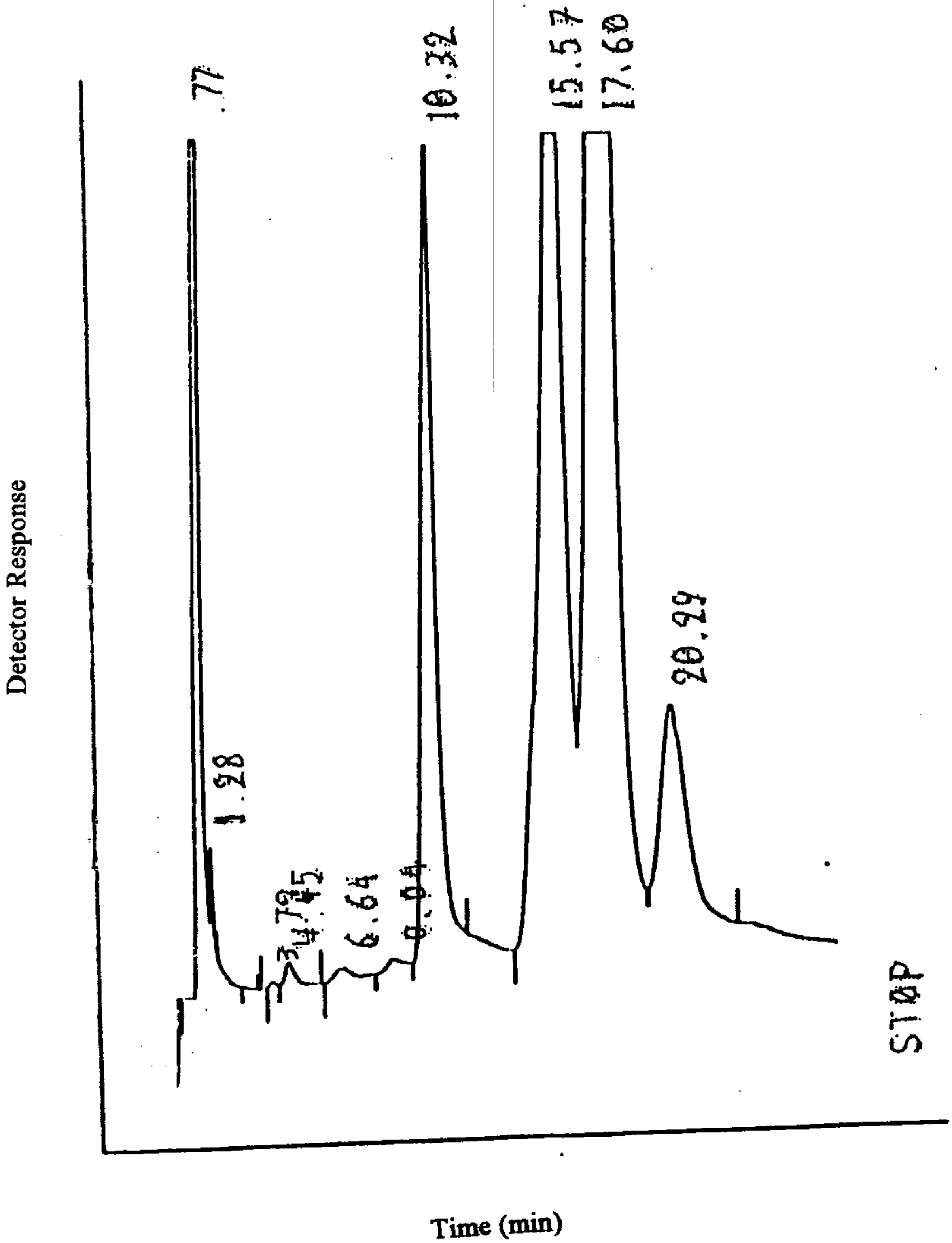

Fig (3) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (22 kg P_2O_5/Fed rock phosphate, recommended rate)

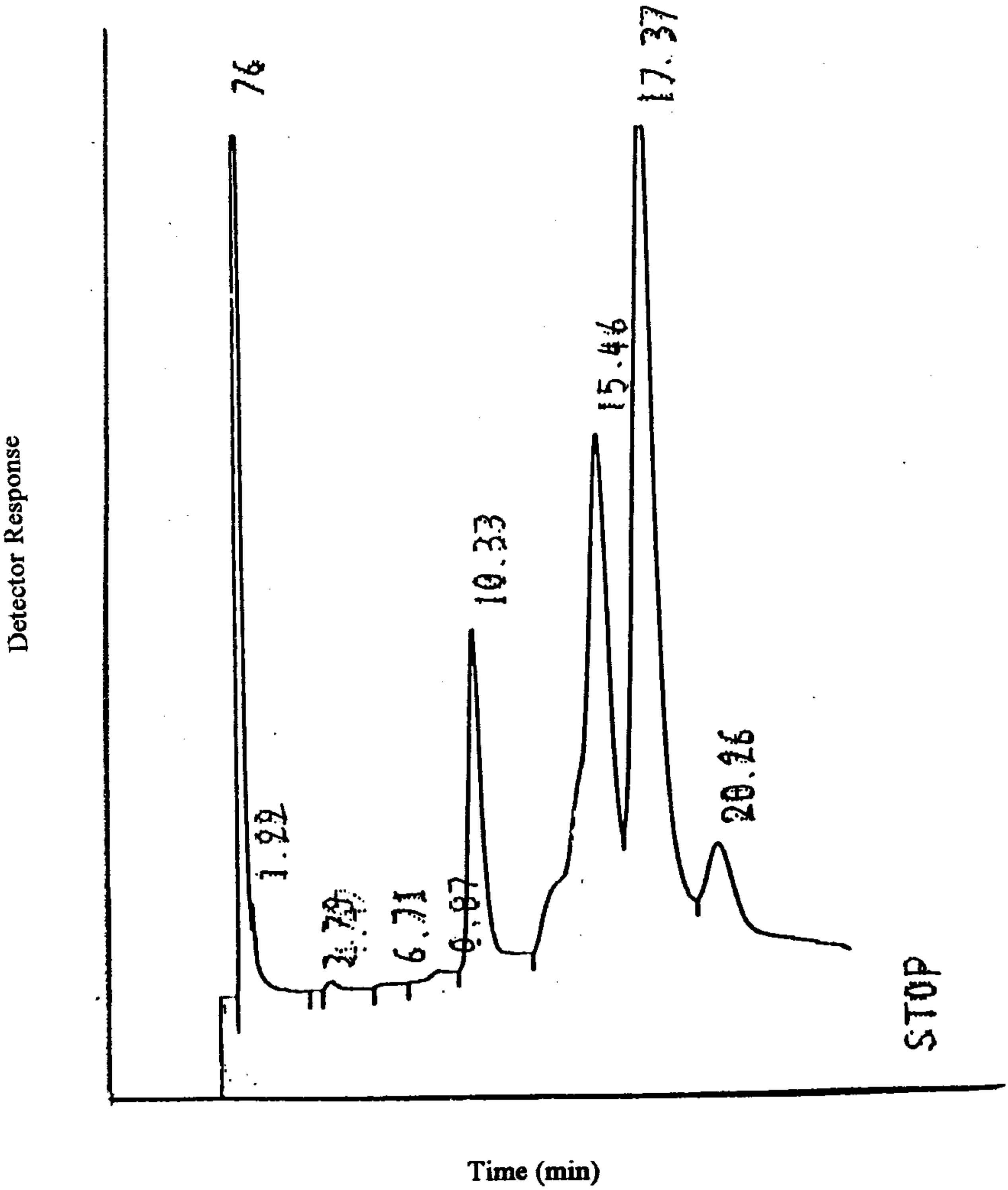

Fig (4) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) ***Phosphorine***

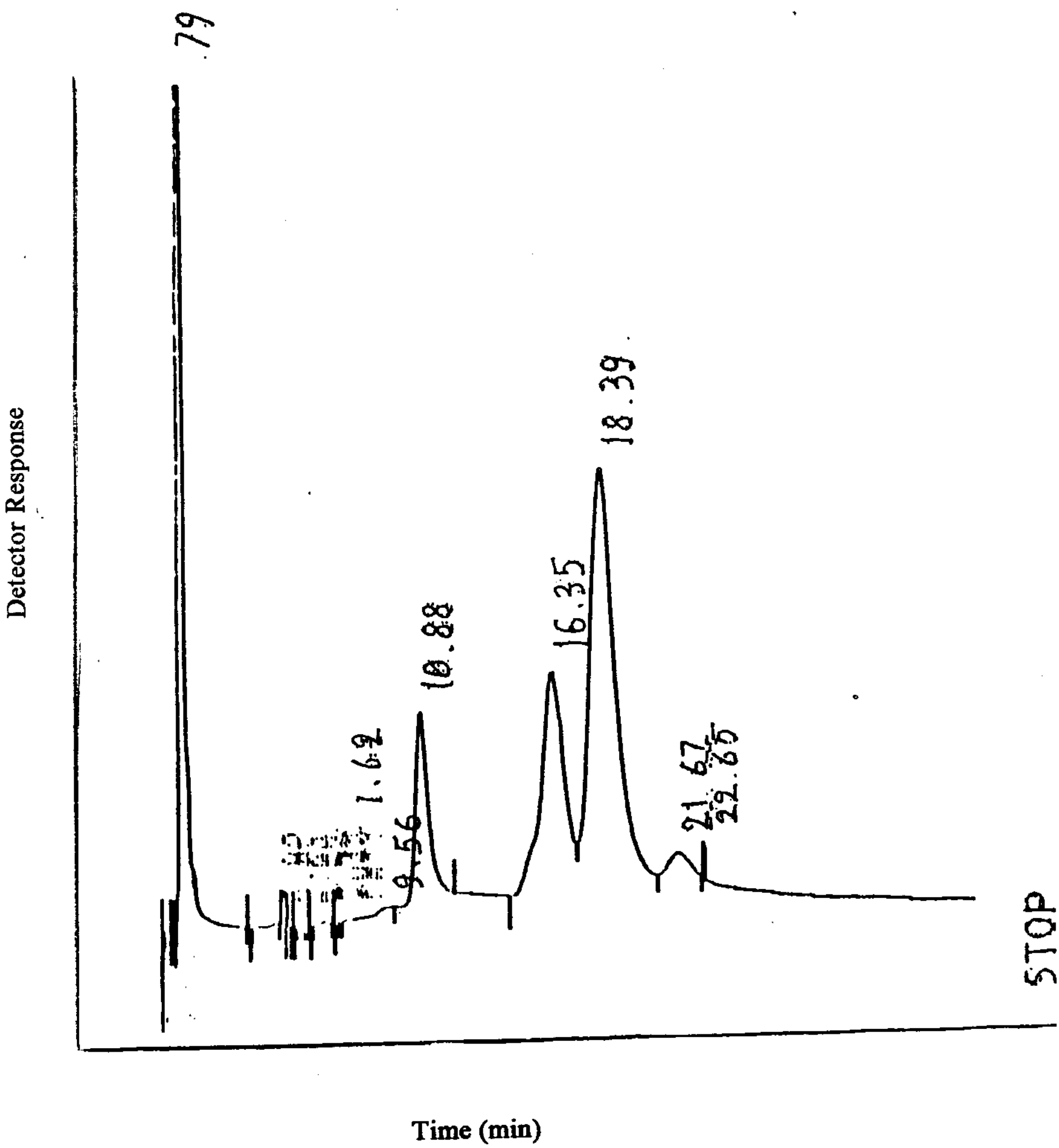

Fig (5): G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) ***Mycorrhizal***

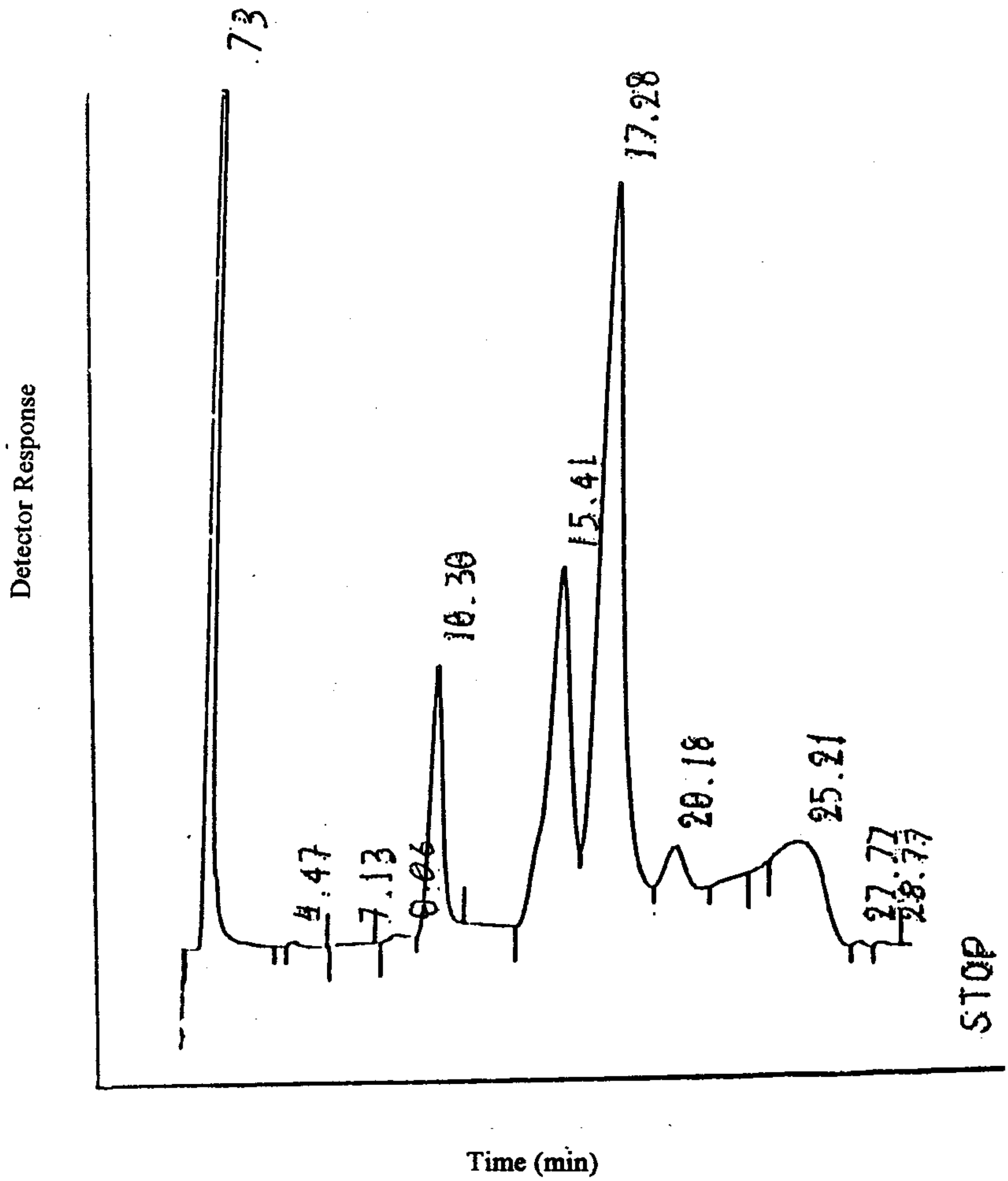

Fig (6) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (16.5 kg P_2O_5/Fed super phosphate + 50 g/Fed ***Phosphorine***

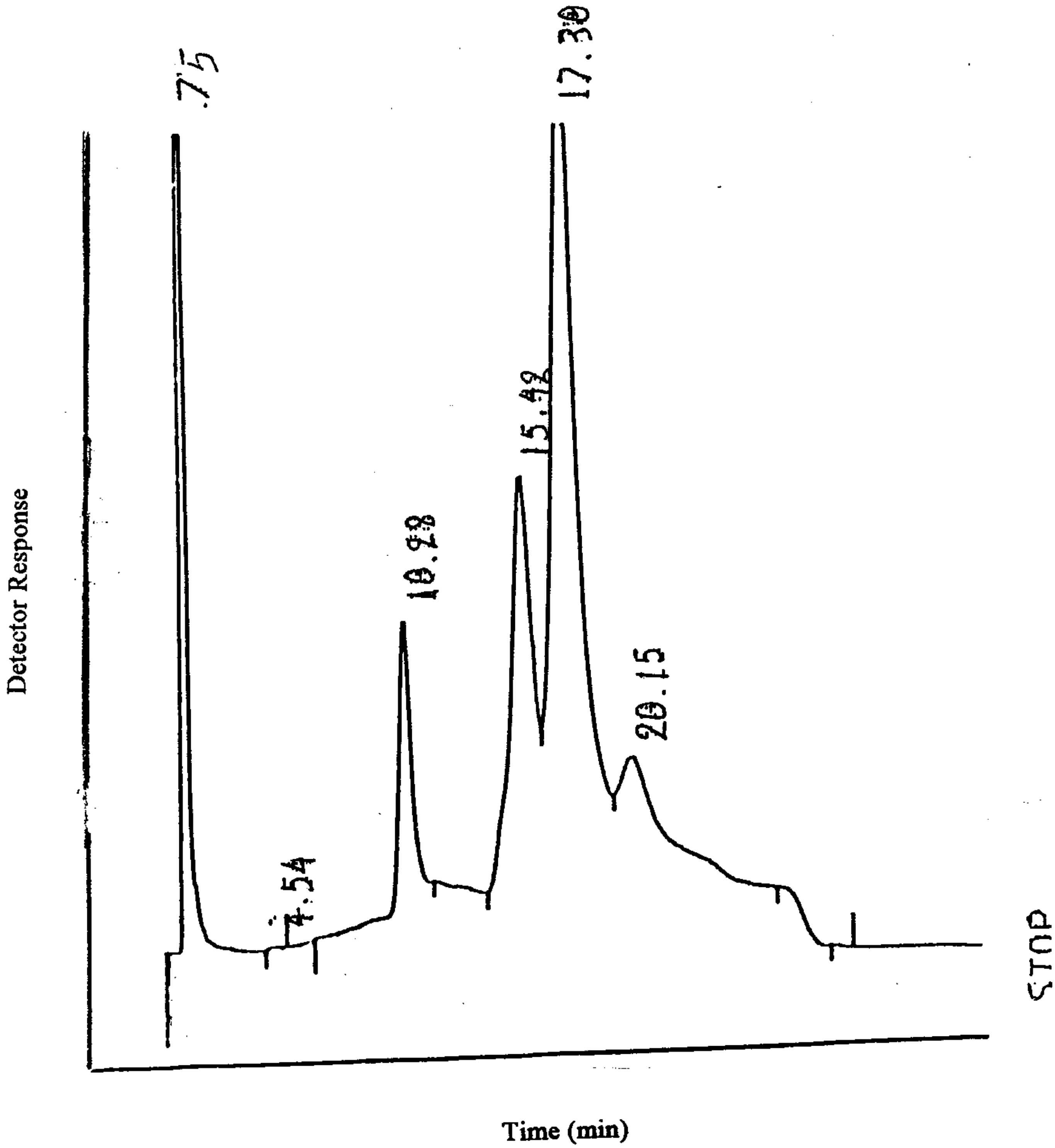

Fig (7) : G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (11 kg P_2O_5/Fed super phosphate + 100 g/Fed ***Phosphorine***

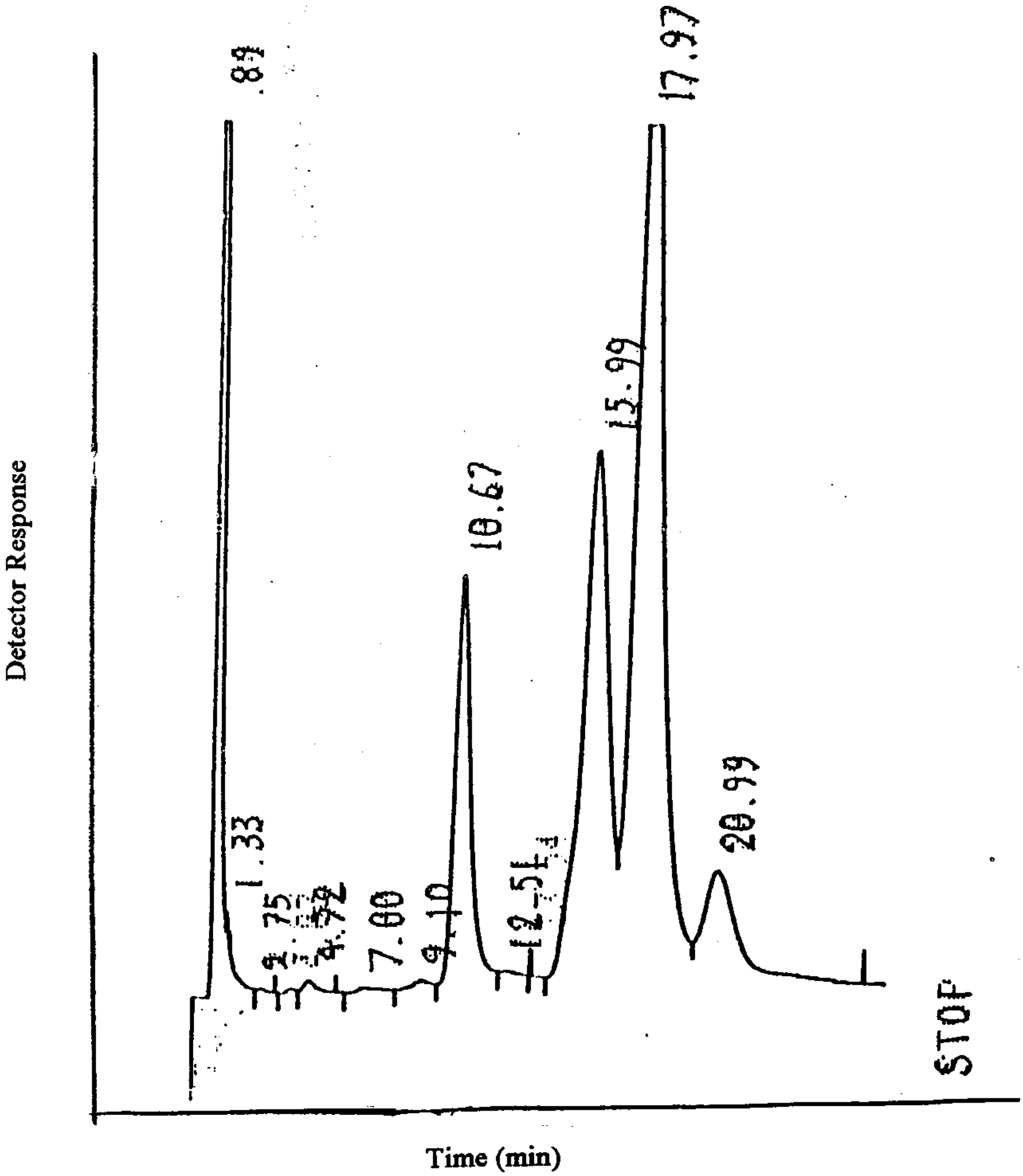

Fig (8): G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (16.5 kg P_2O_5/Fed super phosphate + 50 g/Fed ***Mycorrhizal***

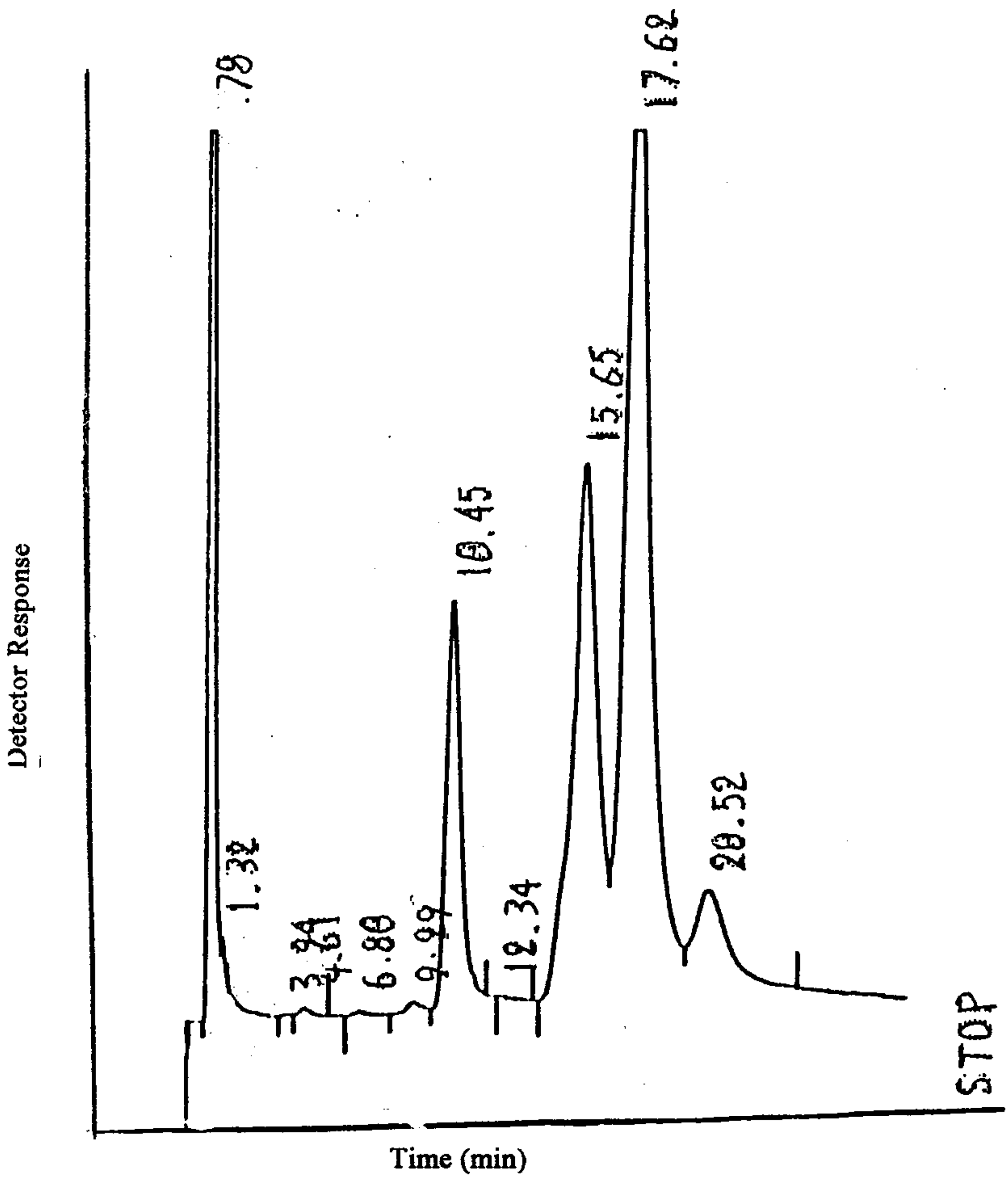

Fig (9): G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (16.5 kg P_2O_5/Fed rock phosphate + 50 g/Fed ***Phosphorine***

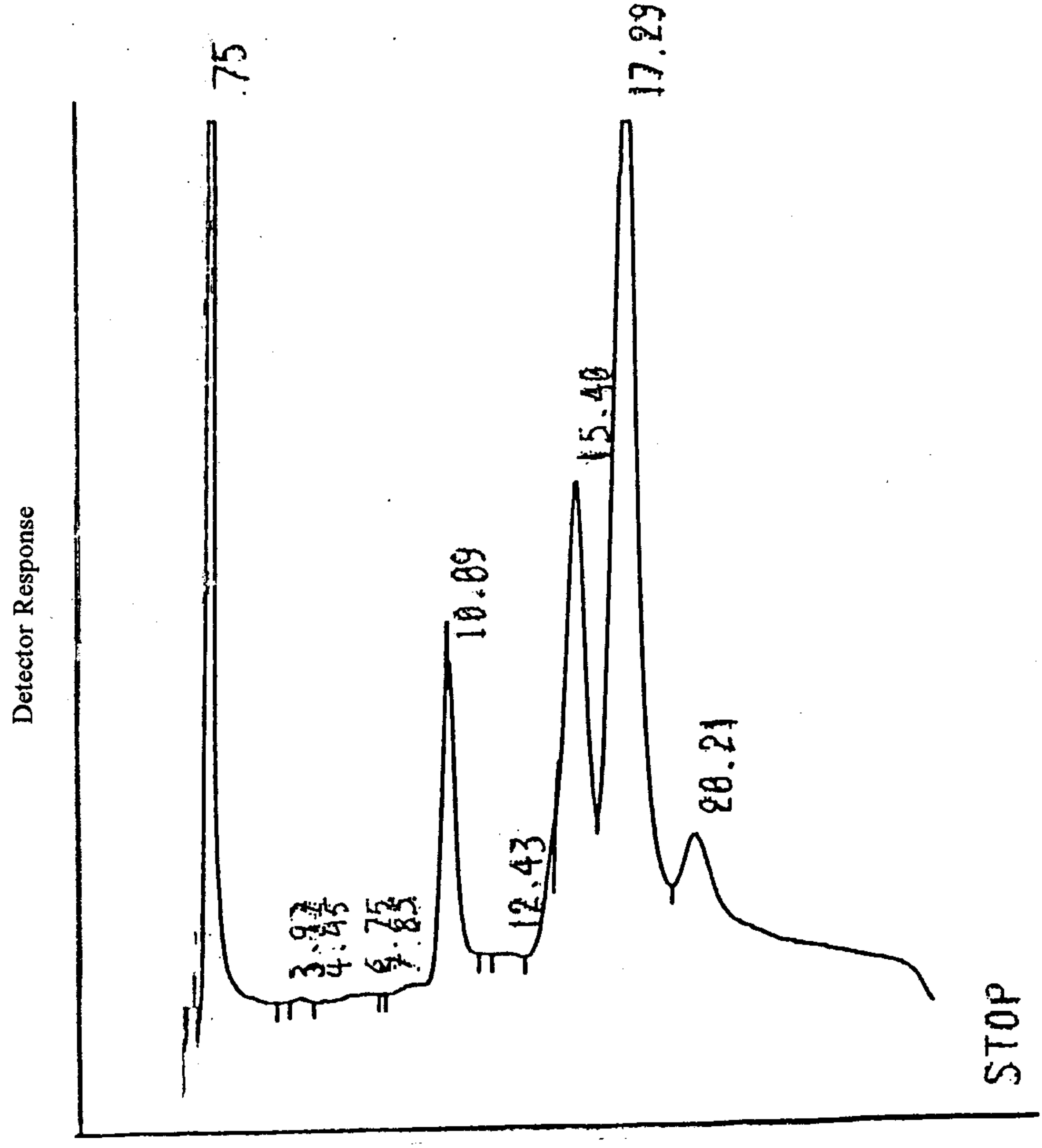

Fig (10): G.L.C. Chromatogram of the fatty acid methyl ester for soybean oil (Clark variety) (16.5 kg P_2O_5/Fed rock phosphate + 50 g/Fed ***Mycorrhizal*** composition of soybean crude fat. The obtained results indicated that all analyzed fat samples has a low content of saturated fatty acids (12.6-18.54%), while the unsaturated fatty acids (TUS) comprise 84.41-87.36%. The major saturated fatty acid was palmitic acid (C_{16}:0), whose percentage ranged between 10.06% and 16.38%. While the predominant unsaturated fatty acid was linoleic acid (C_{18} : 2) whose value varied from 43.96% to 53.84% of the total fatty acids. Oleic acid (C_{18} : 1) content ranged between 23.33 and 28.49%.

Such results are in good agreement with those reported by William (1966) and Swern (1979). The obtained results also showed an inverse relationship between oleic acid and linoleic acid content. Such findings are coincident with that obtained by Cummius ***et al*** (1967).

The obtained results revealed that the treatment with either biofertilizer or mineral fertilizers led to an increment in the values of C_{18} : 2 and TUS in comparison with the control sample. In contrast, the values of C_{16} : 0, TS and C_{18} : 1 decreased with the abovementioned treatments.

Generally, it can be concluded that, the changes in constituents of unsaturated and saturated fatty acids of soybean oil were dependent on the type of treatment (Weingartner, 1987).

4.2.3.2. SDS-PAGE patterns of soybean proteins:

Soybean proteins extracted as early described in materials and methods were subjected to polyacrylamide gell electrophoresis in the presence of sodium dodecyl sulphate (SDS-PAGE).

The pharmacia low molecular weight (L.M.W) calibration kit provides six protein standards covering subunits molecular weights (M.W) ranging from 14.4 to 94 KD were used for constructing the calibration curve.

Table (40) : The molecular weights of the standards protein and relative mobility.

Standard proteins	Molecular weight (M.W)	Log M.W	Relative mobility (Rm)
Phosphorylase b	94000	4.973	0.18
Albumin	67000	4.826	0.26
Pvalbumin	43000	4.633	0.45
Carbonic anhydrase	30000	4.477	0.56
Trypsin inhibitor	20100	4.303	0.74
Lactalbumine	14400	4.158	0.84

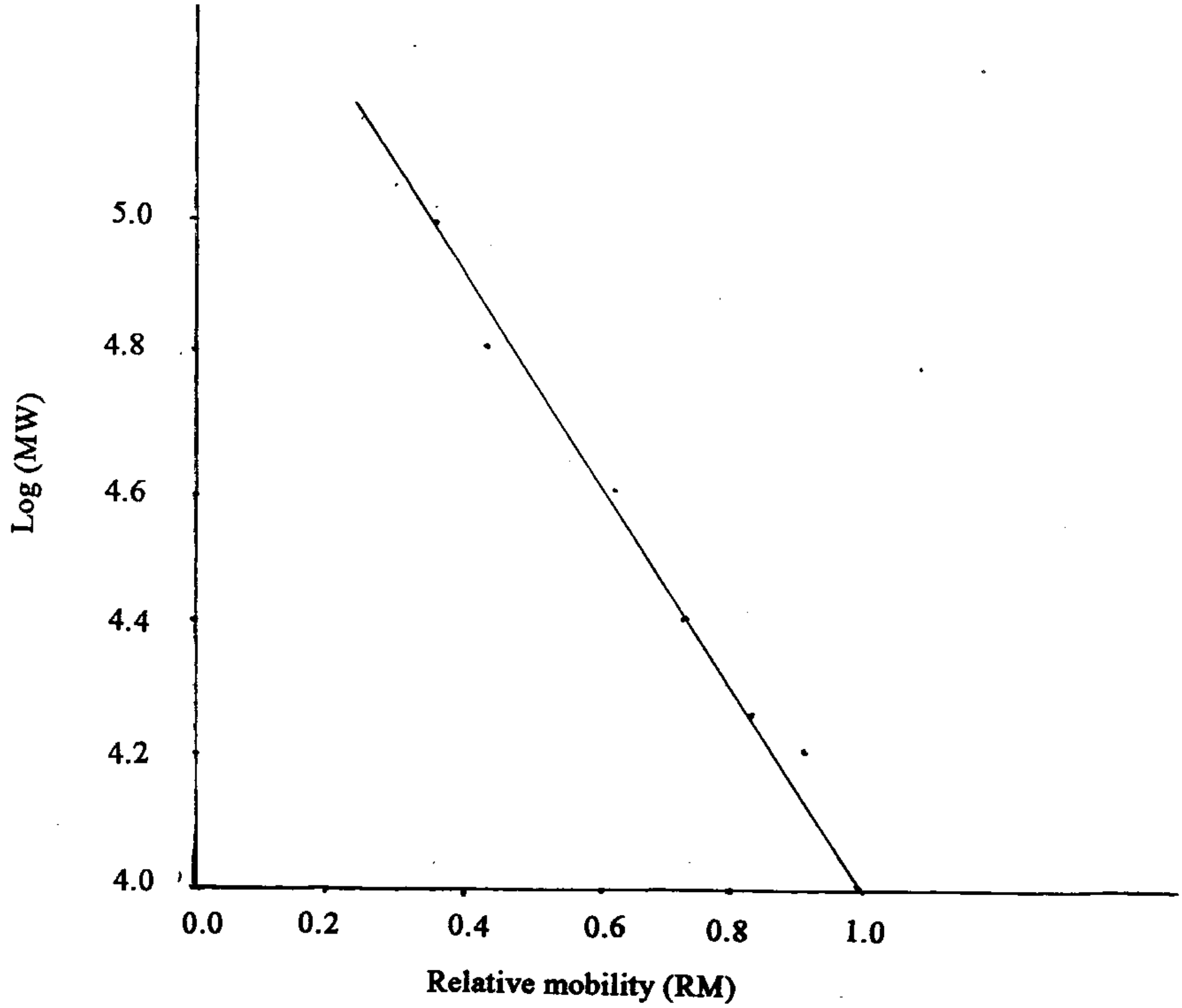

Fig (11): **Calibration curve for M.W determination of subunits of soybean (Clark) protein by SDS-PAGE**

The interaction effect of bio and mineral fertilizers on soybean protein

Clark variety

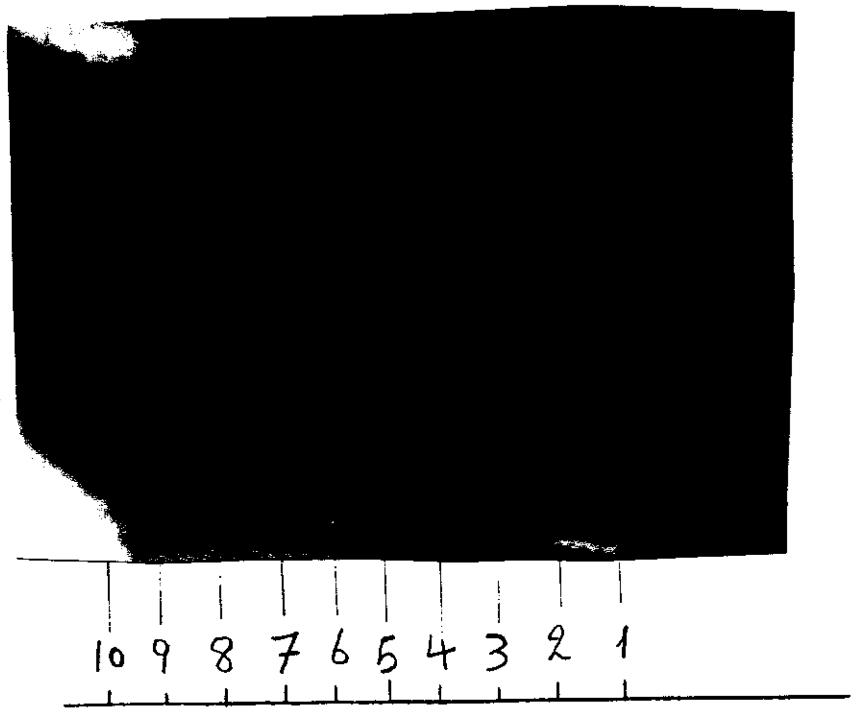

Fig (12): SDS-PAGE pattern of soybean protein

1. Control
2. (22 kg P_2O_5/Fed super phosphate (recommended rate)
3. (22 kg P_2O_5/Fed rock phosphate (recommended rate)
4. ***Phosphorine***
5. ***Mycorrhizal***
6. (16.5 kg P_2O_5/Fed super phosphate + 50 g/Fed ***Phosphorine***
7. (11kg P_2O_5/Fed super phosphate + 100 g/Fed ***Phosphorine***
8. (16.5 kg P_2O_5/Fed super phosphate + 50 g/Fed ***Mycorrhizal***
9. (16.5 kg P_2O_5/Fed rock phosphate + 50 g/Fed ***Phosphorine***
10. (16.5 kg P_2O_5/Fed rock phosphate + 50 g/Fed ***Mycorrhiza***

The relative mobility (Rm) of each protein standard was calculated from (Fig 12) and plotted against its log molecular weight which gave a straight line (Fig 11) from which the molecular size of each subunit of protein samples were determined. The SDS-PAGE patterns of ten soybean protein samples are presented in (Fig 12). From Fig (12), it has been observed that the electrophoretic patterns of the examined protein samples are very similar. Consequently, the obtained results indicated that the environmental factors did not effect on the electrophoretic patterns of soybean proteins.

As shown in Fig (12) each protein was dissociated into at least 15 subunits with molecular weights ranging from 18 to 108 KD. The subunits with molecular weight of 36 KD was the most abundant band in all protein samples followed by that of molecular size of 18 KD. Furthermore, three subuits with molecular weight of 89, 73 and 56 KD were present in higher concentrations in comparison with other subunits with the exception of those of M.W of 36 and 18 KD. Assuming that the higher the protein concentrations the higher the staining intensity of the protein bands.

Thus the 15 subunits detected in protein samples used in this work can be divided into 5 subunits as major bands and 10 subunits minor bands.

Also, the obtained data indicated that at least two of the minor subunits have molecular weights greater than 94 KD.

The obtained results are in agreement with that obtained coincident by Salama (1988) who worked on soybean protein extracted from William variety. Also, the obtained data are partially coincident with those reported by Abd El-Aleem (1992) who investigated the protein of Clark and Crowford varieties.

4.2.4. Follow-up of total nitrogen and available P and K of the soybean-cultivated soil due to fertilization with super phosphate, biofertilizers or both:

Total N content of the phosphatic fertilized soil was generally, higher than that of the control treatment. The fluctuation in nitrogen content of the fertilized soil was very low. However, the soil treated with the super phosphate at its recommended level, or at 75% of this level combined with 50g/Fed of either ***Phosphorine*** or ***Mycorrhizal*** caused the highest soil content of total N. Also, data in Tables (41 and 42) reveal that soil content of total N tended to decrease with time after cultivation and achieved its lowest value at the harvesting stage.

Soil content of available P increased due to the different phosphatic fertilization treatments. The increase was higher upon fertilization with super phosphate at its recommended rate or 75% of this level combined with 50g/Fed of either ***Phosphorine or Mycorrhizal***. However, lower concentrations of the available P were found in the soil upon fertilizing it with the other combinations of super phosphate and the biofertlizers. In all the treatments, the available P content decreased with time. The decrease may be due to fixation of P by the soil clay mineral or surface of the $CaCO_3$ found in the soil. An additional, reason responsible for decreasing the amount of available P is of course its uptake by plant.

Available content of K tended to decrease with time after cultivation regardless of the fertilization treatment. The variation in soil content of available K due to the different fertilization treatments seemed to be very low. Also, no obvious difference in soil content of available K could be seen between the two seasons of cultivation.

The obtained results and the given explanations are in close agreement with many of the previous studies, Yehya and Al-Azawi (1989); Amijee *et al* (1990); Baas (1990); Raiu *et al* (1990) and Smith *et al* (1992).

Table (41) : The interaction effect of biofertilizers and mineral fertilizers on soybean cultivated soil contents of total nitrogen, available P and K at 45 and 75 days after sowing and after harvest in 1992 season.

No	Treatment	Season 1992								
		at 45 days			at 75 days			after harvest		
		Total N %	Available P ppm	Available K me/100g	Total N %	Available P ppm	Available K me/100g	Total N %	Available P ppm	Available K me/100g
1	Control	0.161	9.87	0.945	0.111	8.37	0.849	0.101	7.87	0.662
2	22 P_2O_5 kg/Fed super phosphate	0.294	17.75	1.986	0.202	16.37	1.511	0.151	11.27	1.091
3	22 P_2O_5 kg/Fed Rock phosphate	0.258	14.5	1.642	0.189	12.70	1.342	0.131	9.25	0.911
4	Phosphorine 200 g./Fed (C)	0.237	12.00	1.631	0.180	11.37	1.356	0.125	9.00	0.917
5	Mycorrhizal 200 g/Fed (D)	0.232	9.70	1.621	0.176	8.12	1.353	0.123	7.25	0.915
6	100 g /Fed C. + 100 g/Fed (D)	0.232	10.12	1.626	0.179	8.37	1.358	0.124	7.25	0.916
7	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed C	0.280	19.75	1.987	0.203	18.50	1.523	0.161	13.70	1.113
8	11 P_2O_5 kg/Fed super phos.+100 g/Fed C	0.261	17.50	1.933	0.194	16.50	1.506	0.152	12.35	1.064
9	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed C	0.237	15.50	1.951	0.194	14.37	1.451	0.144	11.47	0.996
10	16.5 P_2O_5 kg/Fed super phos.+50 g/Fed D	0.298	15.75	1.983	0..204	14.62	1.509	0.158	9.97	1.108
11	11 P_2O_5 kg/Fed super phos.+100 g/Fed D	0.265	13.00	1.927	0.196	11.75	1.465	0.155	10.70	1.051
12	5.5 P_2O_5 kg/Fed super phos.+150 g/Fed D	0.215	11.12	1.888	0.189	8.87	1.442	0.150	8.12	0.975
13	16.5 P_2O_5 kg/Fed Rock phos.+50 g/Fed C	0.264	15.62	1.791	0.194	13.12	1.394	0.154	10.30	1.041
14	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed C	0.258	14.30	1.761	0.186	12.12	1.368	0.148	9.62	0.962
15	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed C	0.254	13.37	1.731	0.182	11.12	1.340	0.142	8.92	0.953
16	16.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.261	13.47	1.772	0.191	12.12	1.383	0.151	10.17	0.958
17	11 P_2O_5 kg/Fed Rock phos.+100 g/Fed D	0.257	12.40	1.744	0.183	11.15	1.369	0.149	9.65	0.924
18	5.5 P_2O_5 kg/Fed Rock phos.+150 g/Fed D	0.254	10.40	1.711	0.178	8.62	1.318	0.145	8.15	0.924

5. SUMMARY

Two field experiments were conducted through 1991/1992 and 1992/1993 years at Sids Agricultural Research Station to study the interaction between mineral and biofertilizers on growth, yield and biocontents.

Therefore, sets of field experiments were carried out using cereal crop (wheat) and legumes crop (soybean) as indicator plants.

Wheat plants were individually inoculated with either ***Azotobacter sp*** or ***Azospirillium sp***, while legumes (soybean) were individually inoculated with either phosphorine or ***V.A. Mycorrhizal.***

The obtained results and conclusions can be summarized as follows:

A. **<u>Cereal crops (wheat)</u>**:

1. The application of the mineral fertilizer at 75% of the recommended rate with 50 g/Fed ***Azotobacter sp*** or 50 g/Fed ***Azospirillum sp*** yielded, similar or even higher in plant hight, number of tillers, dry weight, spike length, number of spikelets, number of grains per spike, weight of grain per spike, weight of 1000 grains, grain yield and straw yield than that yielded upon fertilization with the mineral fertilizer.
2. The inoculation of the rhizosphere with either ***Azotobacter sp or Azospirillum sp*** at rate of 50 g/Fed accompanied with fertilization with inorganic nitrogen at 75% of its recommended field rate led to the highest concentrations of N, P and K in wheat plants.
3. The obtained results of plant uptake of N, P and K at both stages of growth (45 and 100 days of planting) indicated that the a significant increment had been occurred by fertilizing the plant with inoculation of the rhizosphere with either ***Azotobacter sp or Azospirillum sp*** at rate of 50

g/Fed accompanied with fertilization with inorganic nitrogen at 75% of its recommended field rate.

4. The obtained data of wheat grain and straw uptake of N,P and K illustrated that a significant of N, P and K uptake with 75% of the recommended rate of the inorganic nitrogen combined with inoculation with 50 g/Fed of either ***Azotobacter sp or Azospirillum sp.***
5. The obtained data indicated that the treatments of (56.25 kg N/Fed + 50 g/Fed ***Azotobacter) and*** (56.25 kg N/Fed + 50 g/Fed ***Azospirillum)*** caused the highest protein value while this treatment caused the lowest value of total carbohydrates and starch content.
6. Results of the follow-up of the soil contents of total nitrogen, available P and K may be due to the different fertilization treatments. Data revealed that in both seasons of cultivation soil contents of the three fertilizer elements were highest upon fertilizing the soil with urea at 75% of its field recommended level) combined with 50 g/Fed of ***Azotobacter sp*** or ***Azospiriluum sp*** inoculated at the plant rhizosphere.

B. <u>Leguminasease (Soybean)</u>:

1. The application of the mineral fertilizer at 16.5 kg P_2O_5/Fed super phosphate with 50 g/Fed phosphorine or 50 g/Fed ***VA-Mycorrhizal*** yielded plant height, number of tillers, dry weight, number of bods per plant, number of seed per plant, weight of seed per plants, weight of 1000 seeds, soybean yield and straw yield, almost similar or even higher than that yield upon fertilization with the mineral fertilizer.

2. The inoculation of the rhizosphere with either phosphorine or *VA. Mycorrhizal* at rate of 50 g/Fed accompanied with fertilization with super phosphate at 75% of its recommended field rate caused the highest concentrations of N, P and K.
3. The obtained results of plant uptake of N, P and K at both stage of growth (45 and 75 days of planting) indicated that a significant increment had been occurred by fertilizing the plant with inoculation of te rhizosphere with either phosphorine or *VA. Mycorrhizal* at rate of 50/Fed accompanied with fertilization with super phosphate at 75% of its recommended field rate.
4. The obtained data of soybean grain and straw uptake of N, P and K indicated that the a significant increase of N, P and K uptake with 75% of the recommended rate of the super phosphate combined with inoculation with 50 g/Fed of either phosphorine or *VA-Mycorrhizal.*
5. The obtained data indicated that the treatments of (16.5 kg P_2O_5/Fed + 50 g/Fed phosphorine) and (kg P_2O_5/Fed + 50 g/Fed *VA-Mycorrhiza*) caused the highest protein and oil value while this treatment caused the lowest value of total carbohydrates.
6. The interaction effect of biofertilizers and mineral fertilizers on the fatty acid composition on soybean crude fat has been studied. The obtained results indicated that all analyzed fat samples had a low content of saturated fatty acids (12.6-18.54%) while the unsaturated fatty acids comprised 84.41-87.36%.
7. The interaction comprised effect of biofertilizers and mineral fertilizers on SDS-PAGE patterns of soybean proteins has been investigated. The obtained results revealed that no differences for each protein in soybean treatment.

8. Results of the follow up of the soil contents of total nitrogen, available P and K is due to the different fertilization treatments. Sata revealed that in both seasons of cultivation soil contents of the three fertilizer elements were highest upon fertilizing the soil wih super phosphate (at 75% of its field recommended level) combined with 50 g/Fed of phosphorine or ***VA-Mycorrhizal*** inoculated at the plant rhizosphere.