RESULTS AND DISCUSSION

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FIRST EXPERIMENT

A. Effect of Nitrogen Application Methods

a. Straw characters

The mean values of straw characters of flax as affected by methods of N application in the three seasons of experimentation are shown in Table 3.

1. Plant height

Results showed that plant height at harvesting time was not significantly affected by the different methods of N application. Such result was true in the three successive seasons indicating the efficiency of soil application, soil spray and foliar application as methods of applying N to flax.

Results showed insignificant increases in plant height in the three experimental seasons when N was applied as soil application. Such increases were, however, below the level of significande. The means of plant height of the three seasons were 73.90, 71.48 and 70.43 cm for soil application, soil spray and foliar spray, respectively.

It could be concluded that soil application of N fertilizer was quite efficient as a method of application under the experimental conditions.

2. Technical length

Results in Table 3 showed that technical length of flax was not influenced by the different methods of N application. In the three seasons, the three methods of N application gave about the same effect on this character.

Similarly, soil application was insignificantly superior to both soil spray and foliar spray. On the average of the three seasons, technical length was 64.67, 62.46 and 60.33 cm for soil application, soil spray and foliar spray, respectively.

Such result is expected since plant height was not significantly affected by the methods of N application.

It could be concluded that applying N in soluble form either to the soil or to the foliage did not prove to be superior to soil application of N in solid form.

3. Straw yield

Similarly, straw yield of flax was not significantly influenced by methods of N application.

The efficiency of the three methods used could be arranged in a descending order in regard to their effect on the straw yield as follows soil application, soil spray and foliar spray, without significant differences in the three seasons.

The overall average of the three successive seasons showed that straw yields were 2121, 2084 and 1939 kg/fad. for soil application, soil spray and foliar spray, respectively.

This result is mainly due to the insignificant effect of application methods on growth characters, namely, plant height and technical length and agrees with those reported by Maddens (1976) who found that straw yield of flax was not affected by N application methods.

On the other hand, Mclvor (1975) showed that N rotated into the soil in the fall was a better source of N for flax leaving it on the surface.

It could be concluded that foliar application and soil spray were not superior to the traditional soil application as method of N application to flax in Egypt. It seems that the enzyme activity in the experimental soil (clay loam) was quite sufficient for converting urea to ammonium N that soil application was quite efficient as a method of application.

In addition, the small area of flax leaves and narrow leaf surface cannot retain a considerable amount of the spray solution. Also the growth habit of flax as a plant with a --

spreading root system in the upper soil layer enables a good absorption of N applied.

b. Seed characters

Data on seed characters of flax as affected by methods of application in the three successive seasons are shown in Table 4.

1. Number of fruiting branches per plant

Results showed that number of fruiting branches / plant was not significantly affected by methods of N application. It was evident that in the three experimental seasons the three methods of N application were equally effective. However, insignificant differences in number of fruiting branches were recorded as a result of different application methods. Soil application showed better effect on this character than soil and foliar spray, and soil spray was of better effect than foliar spray. All differences in number of fruiting branches were below the level of significance.

It could be concluded that soil application is quite efficient as a method of applying N to flax. Foliar or soil spray did not induce flax response to N fertilizer than did soil application.

2. Number of capsules per plant

Results showed also that the number of capsules/plant

Table (3): Effect of nitrogen application methods on straw characters of flax in the three experimental seasons.

Methods of N Application	Plant height cm		Technical length cm		Straw yield kg/fad.	
	1977 / 78					
Soil application	77.44	a	67.50	a	2051	a
Soil spray	76.22	a	66.50	a	2026	a
Foliar spray	75.86	a	65.40	a	1962	a
	1978 / 79					
Soil application	70.03	a	61.52	a	1740	a
Soil spray	66.43	a	58.11	a	1684	a
Foliar spray	64.67	a	54.93	a	1415	a
	1979 / 80					
Soil application	74.23	a	65.00	a	2573	a
Soil spray	71.79	a	62.78	a	2541	a
Foliar spray	70.76	a	60.65	a	2439	a

was not significantly influenced by methods of N application in the three successive seasons.

Soil application showed better effect on this character than foliar spray, but differences were too small to reach the level of significanse.

These results are expected since the number of fruiting branches/plant was not significantly affected by methods of application.

It could be concluded that soil application is ıan effective method of N application under Egyptian conditions.

3. Seed index

Results indicated that seed index was not significantly affected by methods of N application. In the three seasons, applying Nas soil application, soil spray or foliar spray showed similar effect on seed index.

It could be concluded that soil application was quite effective as a method of Napplication.

4. Seed yield

Results showed also that seed yield in the three experimental seasons was not significantly influenced by N application methods.

It is observed from Table 4 that soil application showed better effect on seed yield thansoil and foliar spray. On the average of the three seasons, seed yield of flax supplied with N as soil application increased by about 3 % over that obtained from the soil spray method.

Moreover, seed yield of soil application method was about 15 % more than that obtained from foliar application method on the three seasons average. However, these increases were below the significant level.

The present results indicate that applying N by foliar or soil spray showed no any advantage over the traditional soil application method. Even, slight and insignificant increases in seed yield were obtained when N was applied as soil application when compared with the other methods.

Similar results were also reported by Yermanos et al. (1964), whereas Patel (1977) showed that seed yields were affected by methods of application.

In conclusion, soil application could be recommended as an effective method of N application for flax.

5. Oil percentage

Results indicated also that oil percentage in flax seed was not affected by application methods in the three seasons of experimentation.

Table (4): Effect of nitrogen application methods on seed characters of flax in the three experimental seasons.

Methods of N Application	No of fruiting branches /plant	No. of Capsules / plant	Seed Index g	Seed yield kg/ fad.	Oil %	Oil yield kg/ fad.
		1977 / 78				
Soil application	10.0 a	6.5 a	6.49a	735 a	38.45a	283 a
Soil spray	9.6 a	6.5 a	6.40a	711 a	38.24a	273 a
Foliar spray	8.2 a	5.7 a	6.34a	687 a	38.69a	266 a
		1978 / 79				
Soil application	7.8 a	5.4 a	7.26a	700 a	38.40a	270 a
Soil spray	7.1 a	5.3 a	7.36a	694 a	38.44a	267 a
Foliar spray	6.5 a	4.6 a	7.39a	522 a	38.08a	198 a
		1979 / 80				
Soil application	9.1 a	5.6 a	6.81a	627 a	37.71a	237 a
Soil spray	8.7 a	5.6 a	6.69a	594 a	37.79a	225 a
Foliar spray	7.1 a	4.9 a	6.79a	588 a	37.88a	222aa

application in the three successive seasons are shown in table 5.

1. Fiber yiel.

Results showed that applying N to the soil either in solid form or in spray solution in 1979/80 was significantly superior to foliar application method. In 1979/80 results indicated that fiber yield obtained from soil application and soil spray methods exceeded that obtained from foliar application treatment by 8 and 5 %, respectively.

In 1977/78 and 1978/79 seasons, the three methods of application were similar in their effect on fiber yield. In these two seasons soil application was of better effect on fiber yield as compared with foliar spray, but differences among means of fiber yield due to methods of application were below the level of significance.

The means of fiber yield during the three seasons could be arranged in a descending order in regard to N application methods as follows: Soil application (277 kg/fad.), soil spray (267 kg/fad.) and foliar spray (250 kg/fad.).

It could be concluded that soil application is quite effective as a method of applying N to flax under Egyptian conditions. This method proved superior to foliar application as well as soil spray.

This result could be explained through the effect of applied N in increasing mineralization process of organic soil N in the presence of growing plant (Balba, 1973).

In addition, soil application is quite efficient for N absorption by flax root system, which is known to spread widely into the upper soil layer. Such condition enables an adequate N uptake.

On the contrary, foliar application was less effective due to the fact that flax leaves are narrow and hence the surface subjected to spray solution was not so great for adequate absorption of the soluble N. The low air temperature and the high atmosphere humidity at the time of foliar application are known as factors increasing vapour pressure surrounding flax plants which in turn decrease the ability of the foliage to absorb the applied N.

The present results are expected since soil application was relatively of better effect on straw characters than foliar and soil spray.

Results reported by Kondrat'ev and Podkolzina (1968) showed that urea applied to the soil was quite effective for a high fiber yield. Also Karpova and Filippova (1974) reported that band application of nitrofoska increased fiber yield.

2. Fiber percentage

Results showed that the three methods of N application were similar in their effect on fiber percentage in the three experimental seasons.

Soil application was generally of better effect than foliar and soil spray but differences were not significant.

The means of the three seasons of fiber percentage were 12.91, 12.76 and 12.75 % for soil application, soil spray and foliar spray, respectively.

In conclusion, methods of applying N had no significant effect on fiber percentage.

3. <u>Fiber fineness</u>

Results showed that fiber fineness was not significantly affected by N application methods. These results were true in the three seasons of experimentation.

It seems that fiber fineness is mainly a genetical character which is less influenced by environmental factors.

On the other hand Kuznetsov and Edkov (1972) reported that foliar application of N improved fiber quality of flax.

Table (5): Effect of nitrogen application methods on fiber characters of flax in the three experimental seasons.

Methods of N Application	Fiber yield kg/fad.	Fiber %	Fiber fineness Nm
	1977 / 78		
Soil application	263 a	12.83 a	291 a
Soil spray	255 a	12.60 a	293 a
Foliar spray	249 a	12.70 a	292 a
	1978 / 79		
Soil application	205 a	11.83 a	284 a
Soil spray	196 a	11.79 a	283 a
Foliar spray	166 a	11.77 a	283 a
	1979 / 80		
Soil application	362 a	14.07 a	294 a
Soil spray	359 a	13.89 a	293 a
Foliar spray	335 b	13.79 a	294 a

B. Effect of Nitrogen Fertilizer Levels

a. Straw characters

Data on straw characters of flax as affected by N fertilizer levels in the three seasons of experimentation are shown in Table 6.

1. Plant height

Results showed that N increased significantly plant height of flax plants in the three successive seasons.

Application of 10, 20 and 30 kg N/fad. increased plant height by 5.7, 6.45 and 11.88 cm over the control as an overall average of the three seasons.

It was clear that all differences among the averages of plant heigh were significant except that between 10 and 20 kg N/fad. treatments in the three seasons.

It could be concluded that N is an important element for flax growth. The increase in plant height is mainly due to the effect of N as an essential element forcytoplast formation needed for building, division, development and elongation of plant cells and meristemic tissues that are responsible for the increase in plant height.

Similar results were reported by Canev (1961), El Hariri (1968), El-Farouk (1968), Pande *et al.* (1970), Les

(1974), El-Nkhlawy (1975), Kadry (1976) and Gad and El-Farouk (1978) who found that N fertilizer increased plant height of flax.

2. Technical length

Results indicated that N at all levels caused a significant increase in technical length of flax in the three successive seasons. Maximum technical length was obtained when plants received the highest N level, namely, 30 kg N / fad.

On the average of the three seasons, the application of 10, 20 and 30 kg N/fad. increased technical length by 4.79, 4.44 and 10.31 cm, respectively, over the control. It is clear that no significant difference in technical length was recorded between 10 and 20 kg N/fad. in the three seasons.

It could be concluded that N significantly increased technical length of flax as a result of increasing plant height

The effect of N on technical length is mainly due to the increase in both number and length of the internodes of the main stem.

Several investigators reported also that N increased technical length of flax (El-Hariri, 1968; El-Farouk, 1968; El-Nkhlawy, 1975; Kadry, 1976 and Gad a& El Farouk, 1978).

3. Straw yield

Results indicated that N significantly increased straw yield during the three seasons of experimentation. The highest straw yield was obtained from the highest N level, namely, 30 kg N/fad.

It was clear that in the first and second seasons, the 10 kg N/fad. gave no significant increase in straw yield. The results showed also that in the three seasons, no significant difference was drecorded between 10 and 20 kg N/fad. levels.

Application of 10, 20 and 30 kg N/fad. increased straw yield by 10, 12 and 26 % in 1977/78, 16, 24 and 50 % in 1978/79 and 10, 12 and 25 % in 1979/80, respectively, as compared with the control.

The overall average of the three successive seasons showed that straw yield increased over the control treatment by 11, 15 and 31 % when N was applied at the rate of 10, 20 and 30 kg N/fad., respectively.

It is clear that the highest increase in the three seasons resulted from the highest N level.

This result is expected since N significantly increased flax growth expressed in terms of plant height and technical length.

It could be concluded that N is fundamentally needed for flax under Egyptian environment.

Several investigators reported that N caused an increase in straw yield of flax (Mansour, 1965; El-Hariri, 1968; El Farouk, 1968; Les, 1974; El . Nkhlawy, 1975; Markov, 1975; Kadry, 1976; and Gad a& El Farouk, 1978).

b. Seed characters

Data on seed characters as affected by N fertilizer levels in the three successive seasons are shown in Table 7.

1. Number of fruiting branches per plant

Application of N increased significantly number of fruiting branches/plant in the three seasons.

Significant increases in fruiting branches were only obtained when N was applied at a rate of 30 kg/fad.

Increases in fruiting branches number which resulted from appling N at 10 and 2o kg/fad. levels were not significant.

The response to the different N levels showed similar trend in the three seasons.

The overall average of the three seasons showed that

Table (6): Effect of nitrogen fertilizer levels on straw characters of flax in the three experimental seasons.

N levels kg / fad.	Plant height cm	Technical length cm	Straw yield	
			kg/fad.	rel.
		1977 / 78		
Zero	70.40 c	61.95 c	1797 c	100
10	76.38 b	66.74 b	1975 bc	110
20	77.03 b	65.71 bc	2018 b	112
30	82.21 a	71.55 a	2261 a	126
		1978 / 79		
Zero	61.13 c	52.99 c	1318 c	100
10	66.55 b	57.73 b	1530 bc	116
20	67.43 b	58.05 b	1632 b	124
30	73.07 a	63.95 a	1972 a	150
		1979 / 80		
Zero	66.26 c	57.88 c	2254 c	100
10	71.96 b	62.73 b	2478 b	110
20	72.68 b	62.39 b	2532 b	112
30	78.14 a	68.25 a	2807 a	125

N application at 10, 20 and 30 kg/fad. increased number of fruiting branches/plant over the control by 1.7, 2.4 and 5.3, respectively.

The increase in number of fruiting branches/plant due to increasing N levels may be attributed to the increase in meristemic activity induced by N application.

It could be concluded that N stimulated plant capacity in building up fruiting branches. Such result indicates that N is an essential element for flax.

Similar results were reported by El Hariri (1968), Kondratowicz (1970), Pande et al. (1970) and El Nkhlawy(1975) who found that the number of fruiting branches/plant increased due to N application.

2. Number of capsules per plant

The results showed also that capsule production in flax increased when received N fertilizer. Significant increases in capsule production were recorded when N was applied at 20 and 30 kg N/fad. in the first and third seasons and only at 30 kg/fad. in the second season.

The averages of the three seasons showed that numbers of capsules/plant were 3.9, 4.8, 5.7 and 7.9 at the N level 0, 10, 20 and 30 kg N/fad., respectively.

Such result is mainly due to the stimulating effects of N on growth characters and number of fruiting branches.

Several investigators showed that N application increased the number of capsules/plant (El-Hariri, 1968; El-Farouk, 1968; Prashar *et al.*, 1968; Kondratowicz, 1970; Pande *et al.*, 1970; Al-Shamma and Jabro, 1972; Kadry, 1976 and Gad & El Farouk, 1978).

3. Seed index

Results showed that N application showed no marked effect on seed index. Only in the third season, a significant increase was recorded in seed index when N was applied at a rate of 30 kg N/fad. In the first and second seasons, the effect of N was below the level of significance.

Results reported by El-Hariri (1968), Kinro *et al.* (1970), El Nkhlawy (1975) and Gad &El-Farouk (1978) showed that N increased seed index in flax, whereas Al-Shamma and Jabro (1972) and Kadry (1976) reported that seed index was not influenced by N application.

4. Seed yield

N fertilizer induced a significant increase in seed yield during the three experimental seasons. The highest seed yield was obtained when N was applied at the rate of 30 kg N/fad.

Significant increases in seed yield were obtained when N was applied at 30 kg/fad. in the first and third seasons and at 20 and 30 kg N/fad. in the second season.

Applying N at 10,20 and 30kg/fad. increased the seed yield over the control by 6, 12 and 34 % in the first season, 11, 19 and 42 % in the second season and 7, 10 and 35 % in the third season, respectively.

The average of seed yield in the three seasons increased over the control by 8, 14 and 37 % when N was applied at 10, 20 and 30 kg/fad., respectively.

The effect of N on seed yield might be due to its effect on growth, number of fruiting branches and capsules/plant. This effect demonstrates the role of N as an essential element needed for seed production in flax.

Several investigators reported that N increased flax seed yield (El-Damaty and El-Kobbia, 1956; Gupta et al., 1961; Horodyski and Pietron, 1962; Singh, 1966; El-Hariri, 1968; El-Farouk, 1968; Mokhtar et al., 1970; Les, 1974; El-Nkhlawy, 1975; Kadry, 1976; Les et al., 1977; Gad and El-Farouk, 1978 and Singh and Singh, 1978).

5. Oil percentage

Results in Table 7 indicated that oil percentage in flax seed was not significantly affected by N level in the three successive seasons. Very slight increases were obtained in oil percentage as a result of applying N, particularly at the highest level, i.e., 30 kg N/fad. This N level increased the oil percentage by 0.57, 0.57 and 0.41 % over the control treatment in 1977/78, 1978/79 and 1979/80, respectively, when received 30 kg N/fad. These increases were not significant.

It could be concluded that N had no effect on oil percentagg in flax seed.

Similar results were also obtained by Prased and Biswas (1954), El-Damaty and El-Kabbia (1956), Mathur et al. (1958), Khan et al. (1963), El-Faramawy (1968) and El-Hariri (1968) who found that N applied at different levels neither increased nor decreased oil percentage in flax seed.

On the other hand, Abdul Kareem (1966), Singh (1968), Pande et al. (1970), El-Nkhlawy (1975) and Gad and El-Farouk (1978) reported that N increased oil percentage, whereas Gupta et al. (1961), Dybing (1964), Yermanos et al. (1964), Sexena(1966) Singh et al. (1968) and Singh and Singh (1978) showed that N application decreased oil percentage in flax seed.

6. Oil yield

Oil yield of flax increased as a result of N application. Such increase was mainly due to the increase in seed yield resulting from N application.

Applying N at 10, 20 and 30 kg/fad. increased oil yield by 9, 19 and 39 % over the control treatment, in the first, second and third season, respectively.

It was evident in the three seasons that the maximum average of oil yield resulted from 30 kg N/fad. level.

It could be concluded that oil yield significantly increased by N application. The increase in oil yield resulted from the increases in seed yield and oil percentage.

The present results are in good agreement with those obtained by Shchibraev and Tyurin (1970), Cantar and Pesteanu (1974) and Kadry (1976).

On the other hand, Filipescu and Poparlan (1976) reported that oil yield of flax decreased due to N fertilizer.

c. Fiber characters

Data on fiber characters as affected by N levels in the three experimental seasons are shown in Table 8.

1. Fiber yield

Results indicated that N at all levels significantly increased fiber yield. Fiber yield response to N levels showed a similar trend in the three successive seasons.

Fiber yield increases over the control were 12, 18

Table (7) : Effect of nitrogen fertilizer levels on seed characters of flax in the three experimental Seasons.

N levels kg/ fad.	No. of Fruiting branches / plant	No.of capsules / plant	Seed index g	Seed yield kg/fad.	Seed yield rel.	Oil %	Oil Yield kg / fad.	Oil Yield rel.
				1977/78				
Zero	6.6 b	4.3 c	6.40 a	628 b	100	38.24 a	241 b	100
10	8.5 b	5.1 bc	6.40 a	669 b	106	38.36 a	258 b	107
20	9.5 b	6.6 b	6.41 a	705 b	112	38.44 a	271 b	113
30	12.51 a	9.0 a	6.42 a	843 a	134	38.81 a	327 a	136
				1978/79				
Zero	5.4 b	3.9 b	7.07 a	542 c	100	37.89 a	204 c	100
10	6.8 b	4.9 a	7.18 a	601 bc	111	38.45 a	232 bc	114
20	6.9 b	4.9 b	7.43 a	645 b	119	38.44 a	248 b	122
30	9.5 a	6.6 a	7.66 a	767 a	142	38.46 a	296 a	145
				1979/80				
Zero	5.7 b	3.4 c	6.46 b	533 b	100	37.59 a	200 b	100
10	7.6 b	4.3 bc	6.83 b	572 b	107	37.77 a	216 b	108
20	8.6 b	5.7 b	6.85 b	588 b	110	37.82 a	223 b	116
30	11.6 a	8.1 a	6.92 a	720 a	135	38.00 a	274 a	137

and 36 % in 1977/78, 22, 32 and 66 % in 1978/79 and 14, 19 and 33 % in 1979/80, when N was applied at 10, 20 and 30 kg/fad., respectively. All differences were significant except those between 10 and 20 kg/fad. levels.

On the three seasons average, the application of 10, 20 and 30 kg N/fad. caused an increase in fiber yield over the control by 16, 23 and 45 %, respectively.

It could be concluded that N is an essential element for fiber production. Such result is due to the increase in technical length and straw yield of flax. It was also found that N increased the phloem layer and the amount of cellulose precipitated in the secondary wall of the fiber cells (El-Hariri, 1968).

Several investigators reported also that fiber yield of flax increased by applying N fertilizer (El-Farouk, 1968; El-Hariri, 1968; Deineka, 1974; Efremova, 1974; Novikov, 1975; Gauca and Les, 1976; Kadry, 1976 and Gad and El-Farouk, 1978).

On the other hand, Chen (1960), Iovaisha (1975) and Les and Popirlan (1975) found that fiber yield of flax decreased when received N fertilizer.

2. Fiber percentage

The effect of N application on fiber percentage was only significant in the first experimental season. Results in Table 8 showed that N applied at 20 and 30 kg/fad. significantly increased fiber percentage as compared with the control in 1977/78 season.

In the second and third seasons, N at all levels showed no significant effecton fiber percentage, where all increases in this character were not significant.

The overall average of the three seasons showed that fiber percentage increased over the control by 0.34, 0.55 and 0.82 % when N was applied at the rate of 10, 20 and 30 kg/Fad., respectively.

Results reported by Aukema and Friederich (1959), Cantar and Pesteanu (1974), Kadry (1976) andGad and El Farouk (1978) showed that N increased fiber percentage.

Other investigators, however, showed that N decreased fiber percentage (Konaratowicz, 1970; Iovaisha, 1975; Les and Popirlan, 1975; Kondratowicz, 1977 and Les *et al.*, 1977).

3. Fiber fineness

Results showed that N application at all levels had no significant effect on fiber fineness. It was clear that fiber fineness is mainly a genetical character which is less affected by environmental factors.

Several investigators reported also that fiber fineness was not affected by N application (Aukema and Friederich, 1959; El-Farouk, 1968; El-Hariri, 1968; El-Nkhlawy, 1975 and Kadry, 1976).

On the other hand, Buntush and Likhman (1972), Kerpova and Zinkevich (1972) and Deineka (1974) reported that N inc-, reased fiber fineness of flax, whereas Chen (1960), Konaratow-icz (1970), Iovaisha (1975) and Mikhailova and Mikhaiova (1976) reported that fiber fineness was adversely affected by N application.

Table (8): Effect of nitrogen fertilizer levels on fiber characters of flax in the three experimental seasons.

N levels kg/fad.	Fiber yield kg/fad.	Fiber yield rel.	Fiber %	Fiber fineness Nm.
		1977 / 78		
Zero	220 c	100	12.29 c	294 a
10	247 b	112	12.52 bc	292 a
20	259 b	118	12.84 ab	292 a
30	298 a	136	13.20 a	291 a
		1978 / 79		
Zero	145 c	100	11.40 a	285 a
10	177 b	122	11.77 a	284 a
20	192 b	132	11.85 a	282 a
30	241 a	166	12.17 a	282 a
		1979 / 80		
Zero	300 c	100	13.44 b	294 a
10	343 b	114	13.88 a	294 a
20	356 b	119	14.11 a	293 a
30	399 a	133	14.24 a	293 a

C. Effect of the Interaction Between Nitrogen Application Methods and Nitrogen Fertilizer Levels

The statistical analysis of the data showed that all characters studied, namely, straw, seed and fiber characters were not significantly affected by the interaction between methods of application and nitrogen levels. Consequently, all interactions data were excluded.

That was true in the three seasons of experimentation indicating that each experimental factor acted separately on the studied characters.

In conclusion applying N fertilizer by different methods did not interact with the level of N application. Similarly, the different levels of N used affected straw, seed and fiber characters independently regardless the method used for applying nitrogen.

SECOND EXPERIMENT

A. Effect of Nitrogen Fertilizer Forms

a. Straw characters

Data on straw characters of flax as affected by nitrogen forms in the three seasons of experimentation are shown in Table 9.

1. Plant height

Results indicated that plant height was not significantly influenced by N forms in the three successive seasons. All differences in plant height were too slight to reach the level of significance.

On the average of the three seasons, means of plant height were 80.79, 79.69 and 76.14 cm for urea, ammonium nitrate and ammonium sulphate, respectively.

The present results reveal that the three N carriers used were of similar effect on flax growth expressed in terms of plant height.

Results reported by Shahine (1980) indicated that in the first season (1978) the three N carriers used showed similar effect on cotton plant height, whereas in the second season (1979) ammonium sulphate was superior to ammonium nitrate.

It could be concluded that N forms had no significant effect on flax plant height.

2. Technical length

Similarly, technical length of flax showed no significant response to N form in the three experimental seasons.

The average of the three seasons showed that means of technical length were 69.51, 67.81 and 65.68 cm for ammonium nitrate, urea and ammonium sulphate, respectively. It is clear that technical length followed similar trend as plant height.

3. Straw yield

Results indicated that the three N carriers used, namely, ammonium sulphate, ammonium nitrate and urea gave similar effects on straw yield of flax. This result was true in the three seasons of experimentation indicating equal efficiency of the three carriers for flax grown in Egypt. The overall average of the three seasons showed that straw yield was 2498, 2424 and 2388 kg/fad. for urea, ammonium nitrate and ammonium sulphate, respectively. Differences among the averages of straw yield were below the level of significance.

It could be concluded that amide, ammonium, and nitrate N are quite efficient as N fertilizers for flax grown in Egypt.

Results reported by Danell (1952), Larsen (1962) and

Schnee and Ansorge (1969) showed also that different N forms were of equal effect on straw yield of flax.

On the other hand, Tokuoka and Morooka (1939) and Kondrat'ev and Podkolzina (1968) reported that urea was of better effect on straw yield of flax than the other N carriers.

b. Seed characters

Data on seed characters as affected by nitrogen forms in the three successive seasons are shown in Table 10.

1. Number of fruiting branches per plant

Results indicated that ammonium sulphate, ammonium nitrate and urea were of similar effect on number of fruiting branches/plant in the three experimental seasons. However, urea showed a better effect on this character in the three successive seasons but differences were not great enough to reach the 5 %level of significance.

The three years overall average showed that numbers of fruiting branches/plant were 11.0, 9.9 and 9.3 for urea, ammonium nitrate and ammonium sulphate.

In conclusion, the three N carriers were of equal efficiency on the number of fruiting branches/plant in spit of slight and insignificant differences among the different carriers.

Table (9): Effect of nitrogen fertilizer forms on straw characters of flax in the three experimental seasons.

Nitrogen fertilizer forms	Plant height cm	Technical length cm	straw yield kg/fad.
	1977 / 78		
$(NH_4)_2SO_4$	81.88 a	70.83 a	2305 a
$NH_4\ NO_3$	87.06 a	75.47 a	2193 a
$CO(NH_2)_2$	83.90 a	71.63 a	2388 a
	1978 / 79		
$(NH_4)_2\ SO_4$	71.60 a	60.12 a	2203 a
$NH_4\ NO_3$	74.99 a	63.48 a	2240 a
$CO\ (NH_2)_2$	75.84 a	62.62 a	2243 a
	1979 / 80		
$(NH_4)_2SO_4$	74.95 a	66.09 a	2656 a
$NH_4\ NO_3$	80.31 a	69.59 a	2838 a
$CO\ (NH_2)_2$	79.32 a	69.17 a	2862 a

Under similar experimental conditions, Shahine (1980) showed that cotton plants responded to the three sources of N similarly.

2. Number of capsules per plant

Results indicated that no significant differences among the averages of number of capsules/plant were obtained when flax plants received ammonium sulphate, ammonium nitrate and urea. These results were true in the three seasons of experimentation.

On the overall average of the three seasons number of capsules/plant could be arranged in a descending order in regard to the effect of N form as follows: 6.9 for urea, 6.5 for ammonium nitrate and 6.2 for ammonium sulphate.

Similarly, Shahine (1980) found that number of bolls per cotton plant was not significantly affected by the three N forms used.

It could be concluded that amide, ammonium and nitrate N are equally effective as N fertilizers for flax grown in Egypt.

3. Seed index

Results showed also that seed index was not significantly affected by N forms during the three seasons.

Such results are expected since N forms gave equal effects on fruiting branches and capsules number/plant.

Shanine (1980), on cotton, found also that urea, ammonium sulphate and ammonium nitrate were of similar effects on seed index.

In conclusion, the three N carriers used were of equal efficiency on seed index of flax.

4. Seed yield

Results indicated clearly that seed yield of flax was not significantly affected by N fertilizer forms in the seasons of experimentation.

The overall averages of the three seasons showed that seed yields were 812, 808 and 817 kg/fad. when received ammonium sulphate, ammonium nitrate and urea, respectively.

It is evident that the three N carriers used were quite similar in their effect on seed yield of flax.

This result is expected since yield components, namely, number of branches and capsules/plant and seed index were not significantly influenced by N forms.

Similar results were also reported by El-Damaty and El Kobbia (1956) and Larsen (1962) who found that seed yield of flax was not affected by different forms of N used.

On the other hand, Kondrat'ev and Podkolzine (1968) and Cantar and Pesteanu (1974) found that urea gave a better effect on flax seed yield than the other carriers, whereas Lahola (1975) and Maddens (1976), reported that urea was inferior to other N sources in its effedt on seed yield of flax.

5. Oil percentage

The three N forms were equal in their effect on oil percentage in flax seed during the three seasons.

The overall average of the three seasons showed that oil percentages were 40.95, 40.87 and 40.78 % for ammonium sulphate, ammonium nitrate and urea, respectively.

Similar results were also reported by El-Damaty and El-Kobbia (1956) who found that oil percentage in flax seed was not influenced by N fertilizer form.

It could be concluded that the three forms used were quite effective as N fertilizers for flax.

6. Oil yield

Similarly, oil yield was not influenced by N forms in the three successive seasons.

Such result is expected since oil yield is dependant upon seed yield and oil percentage, which were not affected by N forms.

Table (10): Effect of nitrogen fertilizer forms on seed characters of flax in the three experimental seasons.

Nitrogen fertilizer forms	No. of fruiting branches /plant	No. of capsules /plant	Seed index g	Seed yield kg/fad.	Oil %	Oil yield kg/fad.
			1977 / 78			
$(NH_4)_2SO_2$	11.3 a	7.5 a	6.56 a	903 a	41.26 a	373 a
NH_4NO_3	11.4 a	8.8 a	6.61 a	877 a	41.22 a	362 a
$CO(NH_2)_2$	12.2 a	8.3 a	6.75 a	916 a	41.20 a	377 a
			1978 / 79			
$(NH_4)_2SO_2$	9.8 a	6.6 a	7.21 a	828 a	40.73 a	337 a
NH_4NO_3	9.4 a	6.2 a	7.24 a	838 a	10.84 a	342 a
$CO\ (NH_2)_2$	11.8 a	6.7 a	7.22 a	849 a	40.77 a	345 a
			1979 / 80			
$(NH_4)_2SO_4$	6.8 a	4.4 a	6.84 a	704 a	40.54 a	285 a
NH_4NO_3	8.9 a	5.6 a	6.72 a	709 a	40.55 a	288 a
$CO(NH_2)_2$	9.0 a	5.8 a	6.58 a	690 a	40.38 a	278 a

The three N carriers produced about the same average of oil yield during the three seasons.

In conclusion, amide , ammonium and nitrate N are of equal efficiency for flax grown in Egypt.

c. Fiber characters

Data on fiber characters as affected by N forms in the three experimental seasons are shown in Table 11.

1. Fiber yield

Results indicated that fiber yield in the three successive seasons was not significantly influenced by N fertilizer form.

On the three seasons average, fiber yields were 272, 282 and 280 kg/fad. for ammonium sulphate, ammonium nitrate and urea, respectively.

It is clear that the three carriers were quite similar in their effect on fiber yield, indicating that these fertilizers are quite suitable as N sources for flax under Egyptian conditions.

These results are mainly due to the similar effects of the three N forms on straw characters.

The present results agree with those obtained by Tikhomirova (1968), Andrushkiv et al. (1976), Maddens (1976) and Bockstaeie (1977) who found no clear difference between the averages of fiber yield as a result of applying different N forms.

On the other hand, amide N was more effective than the other forms for fiber flax (Kondrat'ev and Podkolzine, 1968).

2. Fiber percentage

Similarly, fiber percentage was not significantly affected by N forms in the three successive seasons.

The differences between the means of fiber percentage resulting from applying different N forms were below the level of significance.

The overall averages of fiber percentage were 11.26, 11.57 and 11.12 % for ammonium sulphate, ammonium nitrate and urea, respectively.

The present result is mainly due to the similar effect of the three N forms on straw characters as well as on fiber yield.

Several investigators reported the superiority of some N carriers intheir effect on fiber percentage. Tokuoka and Morooka (1939) found that urea gave the highest fiber percentage, whereas Szymanek (1962) showed that sodium nitrate produced the highest fiber percentage.

Also, Cantar and Pesteanu (1974) reported that aqueous ammonia was superior to urea and ammonium nitrate in affecting fiber percentage.

3. Fiber fineness

The three N forms were similar in their effect on fiber fineness in the three experimental season Table 11.

However, ammonium sulphate produced the finest fiber in the three seasons, but differences in fiber fineness were not significant.

The averages of three seasons, showed that means of fiber fineness were 380, 356 and 340 Nm for ammonium sulphate, ammonium nitrate and urea, respectively.

Similar results were also reported by Andrushkiv *et al.* (1976), Lahola (1976) and Maddens (1976) who found that N sources were of similar effects on fiber fineness.

Table (11): Effect of nitrogen fertilizer forms on fiber characters of flax in the three experimental seasons.

Nitrogen Fertilizer forms	Fiber yield kg/fad.	Fiber %	Fiber fineness Nm
	1977 / 78		
$(NH_4)_2SO_4$	256 a	11.05 a	400 a
NH_4NO_3	249 a	11.32 a	355 a
$CO(NH_2)_2$	260 a	10.84 a	337 a
	1978 / 79		
$(NH_4)_2SO_4$	201 a	9.20 a	361 a
NH_4NO_3	230 a	10.46 a	351 a
$CO(NH_2)_2$	223 a	9.95 a	334 a
	1979 / 80		
$(NH_4)_2SO_4$	358 a	13.52 a	380 a
NH_4NO_3	367 a	12.93 a	363 a
$CO(NH_2)_2$	357 a	12.57 a	350 a

B. Effect of Micro-nutrients

a. Straw characters

Results for the effect of micro-nutrients on plant height, technical length and straw yield of flax in the three experimental seasons are shown in Table 12.

1. Plant height

Micro-nutrients application had no significant effect on plant height of flax in the three experimental seasons. Such results cleared that Zn, Cu and Mn either alone or in combinations did not exert any significant effect on flax growth expressed in terms of plant height.

It seems that the requirements of flax plants to these micro-nutrients were enough in the experimental soil that anyapplication was in excess of plant needs.

Similar results were reported by Fahmy et al. (1973) and Kadry (1976) who found that micro-nutrients application did not affect plant height of flax.

Other investigators, however, showed that application of Zn, Cu and Mn either alone or in combinations favourably affected flax growth (Bettini, 1964; Stetsenko and Chepikov, 1970 and Abo-El-Saod et al. 1975).

2. Technical length

Application of Zn, Cu and Mn either alone or in combinations failed to show any significant effect on technical length of flax in the three successive seasons.

The differences among the averages of teahnical length resulting from micro-nutrient application were too slight to reach the level of significance.

These results are mainly due to the insignificant effect of micro-nutrients on plant height.

The present result agree with those reported by Fahmy et al. (1973) and Kadry (1976) who found that Mn, Zn or Cu application did not affect technical length of flax.

On the other hand, Bottini (1964) and Stetsenko and Chepikov (1970) found that growth characters of flax were positively affected by Zn, Cu, and Mn application.

3. Straw yield

Non of the three micro-nutrients used or their combinations showed significant effect on straw yield of flax during the three successive seasons.

It seems that micro-nutrients applied were an excess of plant needs that straw characters as well as straw yield were not positively affected.

Table (12) : Effect of micro-nutrients on straw characters of flax in the three experimental seasons.

Micro-nutrients	Plant height cm	Technical length cm	Straw yield kg / fad.	Straw yield rel.
		1977/78		
Control	84.04 a	71.28 a	2357 a	100
Zn	81.57 a	73.28 a	2298 a	98
Cu	84.50 a	73.07 a	2343 a	99
Mn	83.51 a	71.83 a	2259 a	96
Zn+Cu	85.34 a	74.48 a	2235 a	95
Zn+Mn	86.28 a	73.96 a	2341 a	99
Cu+Mn	85.00 a	72.74 a	2270 a	96
Cu+Zn+Mn	84.01 a	70.52 a	2259 a	96
		1978/79		
Control	74.65 a	62.32 a	2125 a	100
Zn	74.86 a	62.80 a	2202 a	104
Cu	73.81 a	61.83 a	2159 a	102
Mn	75.77 a	62.31 a	2300 a	108
Zn+Cu	73.09 a	61.48 a	2197 a	103
Zn+Mn	73.65 a	61.38 a	2265 a	107
Cu+Mn	74.69 a	62.43 a	2179 a	103
Zn+Cu+Mn	72.80 a	62.00 a	2402 a	113
		1979/80		
Control	79.48 a	69.30 a	2859 a	100
Zn	77.44 a	67.86 a	2785 a	97
Cu	77.93 a	68.72 a	2611 a	91
Mn	78.12 a	68.02 a	2889 a	101
Zn+Cu	76.37 a	65.92 a	2754 a	96
Zn+Mn	77.14 a	67.74 a	2769 a	97
Cu+Mn	80.58 a	70.54 a	2742 a	96
Zn+Cu+Mn	78.48 a	68.17 a	2870 a	100

Similar results were also reported by Fahmy et al. (1973) and Kadry (1976) who found that Mn, Cu and Zn had no significant effect on straw yield, whereas, Stetsenko and Chepikov (1970) and Abo El Saod et al. (1975) found that micro-nutrients resulted in increasing the straw yield.

Results reported by Porokhnevich and Bykov (1972) showed that Zn application caused an increase in straw yield, whereas Cu application decreased straw yield.

b. Seed characters

Data on seed characters as affected by micro-nutrients in the three experimental seasons are shown in Table 13.

1; Number of fruiting branches per plant

Results indicated that only in the first season micro-nutrients significantly affected number of fruiting branches/plant. In that season, some micro-nutrient treatments were significantly superior than other treatments. For example, Zn + Mn and Zn + Cu + Mn were significantly superior to streatments containing Zn, Cu and Zn + Cu. That indicates the Mn either alone or in combinations was of superior effect on number of fruiting branches/plant. It was also clear that none of the micro-nutrient treatments was significantly different from the control treatment.

In the first season, treatments could be arranged in a descending order inregard to their effect on number of fruiting branches as follows:

Zn + Mn, Zn + Cu + Mn, Cu + Mn, control, Mn, Zn, Zn + Cu and Cu .

In the second and third seasons, all differences among micro-nutrient treatments were not significant. It was observed in these seasons that Mn either alone or in combinations with Cu or Zn was of better effects.

The overall average of the three seasons showed also that Mn + Cu, Mn + Zn + Cu, Mn , Mn + Zn treatments ranked as the first four treatments followed by the control than Zn, Cu and Zn + Cu.

It could be concluded that Mn seemed to have better effect on number of fruiting branches than Zn or Cu. This effect reached the significant level in one season out of th three.

Fahmy et al. (1973) reported that number of fruiting branches/plant was .ot affected by Mn application.

2. Number of capsules per plant

Results showed also that micro-nutrients showed significant effect aon number of capsules/plant only in the first season.

Treatments including Mn either alone or in combination were superior to other micro-nutrients. Micro-nutrient treatments in the first season could be arranged in a [illegible]

descending order in regard to their effect on number of capsules/plant as follows:
Zn + Mn, Zn + Cu + Mn, Cu + Mn, control, Mn, Zn , Zn + Cu and Cu.

In the second and third seasons no significant effects for all micro-nutrients under study were detected.

On the overall average of the three seasons, the treatments showed tha same trend as that in the first season and were arranged in a descending order as:
Cu +Mn+Cu+Zn+ Mn, Zn + Mn, Mn, Control, Zn, Cu and Zn + Cu.

In conclusion, Mn was of better effect than Cu and Zn on number of capsuls/plant.

Such results are expected since similar results were obtained for the effect of micro-nutrients on number of fruiting branches/plant.

Results reported by kadry (1976) showed that number of capsules/plant was not affected by Zn or Cu application, whereas Abo-El-Saod et al. (1975) reported that Zn increased this character.

3. Seed index

Results presented in Table 13 showed that all micronutrient treatments had no significant effect on seed index in the three successive seasons.

All differences in this character were too slight to reach the level of significance.

Similar results were also obtained by Fahmy et al. (1973), with Mn, and Kadry (1976) with Cu and Zn.

On the other hand, Chepikov and Shchetinina (1968) Abo- El-Saod et al. (1975), obtained marked increases in seed index as a result of applying Cu and Zn, respectively.

4. Seed yield

Results showed that seed yield was not significantly by micro-nutrient application in the three successive seasons.

None of the micro-nutrient treatments exerted significant effect on seed yield in any season.

As an overall average of the three seasons, treatments could be arranged in a descending order in regard to their effect on seed yield as follows:
Zn + Cu + Mn, Cu + Mn, Zn + Mn, Zn + Cu, Mn, Control, Zn and Cu.

It could be concluded that micro-nutrient application was an exess of plant needs under the experimantal conditions.

The present results agree with those obtained by Dastur and Bhatt (1965), Fahmy et al. (1973), Kadry (1976) and Spratt and Smid (1978).

On the other hand, Baryshpol (1962), Batagen and Beiyankina (1968), Chepikov and Shchetinina (1968 and 1970), Stetsenko and Chepikov (1970) and Shekhawat et al. (1971) showed that Cu increased seed yield of flax. Zinc was also effective in increasing flax seed yield (Abo El Saod, et al., 1975).

5. Oil percentage

Oil percentage was significantly affected by micro-nutrient application in the three successive seasons.

In the three seasons, all micro-nutrient treatments were significantly superior to the control treatment in their effect on oil percentage.

Increases in oil percentage over the control ranged from 1.96 to 3.87 %, 2.17 to 3.82 % and 2.2 to 3.72 % in the first, second and third season, respectively.

In general, Mn and Cu either alone or in combination induced highest increases in oil percentage.

On the average of the three seasons, micro-nutrients could be arranged in a descending order in regard to their effect on oil percentage as follows:
Zn + Cu + Mn (41.84 %), Cu (41.83 %), Mn (41.81 %), Cu + Mn (41.74 %), Zn +Mn (40.51 %), Zn + Cu (40.46 %), Zn (40.31 %) and control (38.14 %).

It could be concluded that micro-nutrients significantly increased oil percentage in flax seeds.

Such results might be due to the effect of micro-nutrients on some physiological processes in plant.

Mn is a privileged ion in the activity of a great scale of enzyme processes particularly in the fatty acid synthesisfrom acetyl-Co A, (Street and Cockburn, 1972). Its deficiency results in a lack in the formation of plastid lamella as lipids due to the disturbance in lipid metabolism, its definiency also causes a blocking in the chlorophyll formation, inhibition of phosphorylation.

Cu is nearly similar to Mn in its functions especially those related indirectly to the fat metabolism, photosynthesis process, chlorophyll formation and some respiratory enzymes (Amberger, 1974).

Similar results were also reported by Batagin and Beiyankina (1968), Chepikov and Shchetinina (1968), Fahmy et al. (1973) and Kadry (1976) who found that Cu and Mn increased oil percentage in flax seed.

6. Oil yield

Results showed that oil yield markedly increased as a result of applying micro-nutrient in single as well as in different combinations.

The good effect of micro-nutrients on oil yield

Table (13): Effect of micro-nutrients on seed characters of flax in the three experimental seasons.

Micro-nutrients	NO. of fruiting branches /plent	NO. of capsules/ plant	Seed index g	Seed yield kg/fad.	Seed yield rel.	Oil %	Oil Yield kg/fad.	Oil Yield rel.
			1977/78					
Control	11.9 abc	7.9 abcd	6.60 a	877 a	100	38.52 c	338 a	100
Zn	10.8 bc	7.2 bcd	6.63 a	930 a	106	40.66 b	378 a	112
Cu	9.8 c	6.8 d	6.55 a	893 a	102	42.29 a	377 a	112
Mn	11.4 abc	7.7 bcd	6.61 a	888 a	101	42.39 a	376 a	111
Zn+Cu	10.2 c	6.9 cd	6.64 a	903 a	103	40.73 b	368 a	109
Zn+Mn	13.5 a	9.4 a	6.60 a	917 a	104	40.48 b	370 a	110
Cu+Mn	12.6 ab	8.4 abc	6.61 a	917 a	105	42.33 a	388 a	115
Zn+Cu+Mn	13.1 a	8.6 ab	6.88 a	870 a	99	42.39 a	369 a	109
			1978/79					
Control	10.0 a	6.2 a	7.14 a	823 a	100	38.11 c	314 a	100
Zn	10.8 a	6.8 a	7.03 a	819 a	100	40.28 b	330 a	105
Cu	10.3 a	6.8 a	7.26 a	806 a	98	41.93 a	338 a	108
Mn	11.2 a	6.9 a	7.33 a	850 a	103	41.75 a	354 a	113
Zn+Cu	10.7 a	6.8 a	7.47 a	839 a	102	40.28 b	338 a	108
Zn+Mn	9.9 a	6.0 a	7.33 a	838 a	102	40.70 b	341 a	109
Cu+Mn	11.0 a	7.1 a	7.17 a	833 a	101	41.58 a	346 a	110
Zn+Cu+Mn	8.9 a	5.6 a	7.04 a	889 a	108	41.61 a	370 a	118
			1979/80					
Control	8.6 a	5.3 a	6.80 a	721 a	100	37.80 b	272 bc	100
Zn	8.2 a	5.2 a	6.48 a	645 a	90	40.00 a	258 c	95
Cu	8.3 a	5.3 a	6.53 a	684 a	95	41.28 a	282 bc	104
Mn	8.2 a	5.3 a	6.81 a	708 a	98	41.30 a	293 ab	108
Zn+Cu	6.8 a	4.3 a	6.98 a	694 a	96	40.37 a	280 bc	103
Zn+Mn	7.4 a	4.7 a	6.74 a	704 a	98	40.35 a	284 abc	104
Cu+Mn	9.1 a	5.8 a	6.59 a	708 a	98	41.31 a	292 ab	107
Zn+Cu+Mn	9.1 a	6.1 a	6.76 a	745 a	103	41.52 a	309 a	114

showed no significant effect on fiber yield in the three successive seasons.

It is clear that fiber yield followed similar trend as straw yield.

It could be concluded that applying Zn, Cu and Mn either alone or in different combinations did not induce fiber yield increase.

Similar results were reported by Kadry (1976) who found that Cu and Zn application had no effect on fiber yield of flax.

On the other hand several investigators showed that Cu (Drozdov and Shcherbakov, 1955; Baryshpol, 1962; Rodewald and Ulbricht, 1963; ALesik and Chepikov, 1966; Batagin and Beiyankina, 1968; Chepikov and Shchetinina, 1968; and 1970; Stetsenko and Chepikov, 1970 and Sen'Kov, 1974), Mn (Rodewald and Ulbricht, 1963; Batagin and Beiyanking, 1968 and Sen'Kov, 1974) and Zn (Sen'kov, 1974) increased fiber yield of flax.

2. Fiber percentage

In the three successive seasons fiber percentage was not significantly influenced by micro-nutrient application. Such result are expected since straw yield as well as fiber yield were not affected by micro-nutrient application.

It could be concluded that fiber percentage did not significantly respond to micro-nutrient application.

These results agree with those reported by Kadry (1976), working under similar experimental conditions.

On the other hand Lesik and Senkov (1974), using Mn, and Abo-El-Saod et al. (1975), using Zn, showed that fiber percentage increased as a result of micro-nutrient application.

3. Fiber fineness

Results in Table 14 indicated that applying Zn, Cu and Mn either alone or in different combinations significantly increased fiber fineness in the three successive seasons. All micro-nutrient treatments significantly surpassed the control treatment in the three seasons.

Results cleared that best results were obtained when the three micro-nutrients were combined.

On the average of the three seasons treatments could be arranged in a descending order in regard to their effect on fiber fineness as follows:
Zn + Cu + Mn, Cu, Mn, Cu + Mn, Zn + Cu, Zn + Mn, Zn and the control.

It could be concluded that fiber fineness was markedly improved as a result of micro-nutrient application.

Results reported by Drozdov and Shcherbakov, 1955;

Table (14): Effect of micro-nutrients on fiber characters of flax in the three experimental seasons.

Micro-nutrients	Fiber yield kg / fad.	Fiber yield rel.	Fiber %	Fiber fineness Nm.
		1977/78		
Control	265 a	100	11.31 a	303 f
Zn	262 a	99	11.30 a	352 e
Cu	257 a	97	11.02 a	395 b
Mn	243 a	92	10.74 a	372 c
Zn + Cu	234 a	88	10.41 a	363 cd
Zn + Mn	273 a	103	11.64 a	355 de
Cu + Mn	261 a	99	11.39 a	363 cd
Zn + Cu + Mn	245 a	93	10.74 a	411 a
		1978/79		
Control	216 a	100	10.35 a	285 c
Zn	224 a	104	10.24 a	335 b
Cu	195 a	90	8.98 a	374 ab
Mn	210 a	97	9.20 a	356 b
Zn + Cu	203 a	94	9.31 a	353 b
Zn + Mn	242 a	112	10.70 a	337 b
Cu + Mn	235 a	109	10.74 a	354 b
Zn + Cu + Mn	222 a	102	9.44 a	396 a
		1979/80		
Control	361 a	100	12.67 a	293 e
Zn	261 a	100	13.11 a	352 b
Cu	359 a	100	13.82 a	403 ab
Mn	374 a	104	13.03 a	372 b
Zn + Cu	336 a	93	12.26 a	355 b
Zn + Mn	369 a	102	13.34 a	354 b
Cu + Mn	359 a	100	13.06 a	357 b
Zn + Cu + Mn	367 a	102	12.79 a	428 a

Batagin and Beiyankina, 1968; Chepikov and Shchetinina, 1968; Stetsenko and Chepikov, 1970; Lesik and Sen'kov, 1974 and Abo-El-Saod et al., 1975 (using Cu), Batagin and Beiyankina 1968, (using Mn) and Lesik and Sen'kov,1974 (using Zn + Cu + Mn) showed that micro-nutrients increased considerably fiber fineness in flax.

On the other hand Kadry (1976) found that neither Zn nor Cu exerted significant effect on fiber fineness.

C. Effect of The Interaction Between Nitrogen Forms and Micro-nutrients

Results showed that in the three successive seasons, all effects of the interaction between nitrogen forms and micro-nutrients on straw, seed and fiber characters were not significant.

Such result indicates that each experimental factors acted independently in affecting the studied characters.

D. Effect of Nitrogen Forms and Micro-nutrients on Dry Weight and Chemical Content of Flax

I: Dry Weight Per Plant

Data on dry weight of flax as affected by N forms and micro-nutrients at different growth stages in 1978/79 and L979/80 seasons are given in Table 15 and Figures 1 and 2.

1. Effect of nitrogen forms

Results showed that N forms had a significant effect on dry weight/plant at different stages of growth.

In both seasons, dry weight at earlier growth stage (42 days) was favourably affected by ammonium nitrate.

With advanced growth (63 days), urea showed better effect on dry weight. With further advance in growth (84 days) the three N carriers were of equal effect on dry weight. At harvest, ammonium nitrate was superior in 1978/79 whereas urea was more effective in 1979/80 on dry weight plant as well as on dry weight of seeds/plant.

In conclusion N forms showed different effects on plant dry weight according to the stage of growth.

Such result may be due to the differences in the rate of oxidation and transformation processes of N present in the different carriers used.

Results reported by Kondrat'ev and Podkolzine (1968) indicated that urea was more efficient as N carrier for flax.

On the other hand, Lahola (1976) found that urea reduced flax straw yield.

2. Effect of micro-nutrients

Results in Table 15 showed that micro-nutrients had significant effect on dry weight/plant in both seasons.

Micro-nutrient application increased dry weight/plant at 63 days in both seasons and at 84 days in 1979/80 seasons. At harvest the effect of micro-nutrients was not significant.

It was evident that the best results were obtained when Zn and Mn were applied either alone or in combination.

Also, dry weight of flax seed/plant significantly increased as a result of micro-nutrient application in both seasons. Highest seed dry weights were obtained when Mn and Cu were applied alone or when combinations of the three elements were used.

The good effect of micro-nutrients on dry weight may be due to the important function of Mn in plant metabolism especially in chlorphyll synthesis, photosynthesis, activation of different enzymes and finally in phytohormone regulation (Amberger, 1974).

Also Copper takes part in the development of chloroplasts which are the centers of numerous enzymes (Amberger, 1974).

3. Interaction effects

Results in Tabbe 15 showed that dry weight/plant was significantly affected by the interaction between N forms and micro-nutrients at 63 days in both seasons and at 84 days in 1978/79 season.

Also, seed dry weight/plant was significantly affeced ted by that interaction in both seasons.

It was claar that at 63 days, the highest dry weight /plant was achieved when urea was applied to plants treated with Zn + Cu in 1978/79 and Cu + Mn in 1979/80.

The lowest dry weight at 63 days was when plants were fertilized with ammonium nitrate and untreated with micro-nutrients.

The highest seed dry weight/plant was when the three micro-nutrients were applied in combination to plants treated with ammonium nitrate in both seasons.

of growth in 1978/79 and 1979/80 seasons

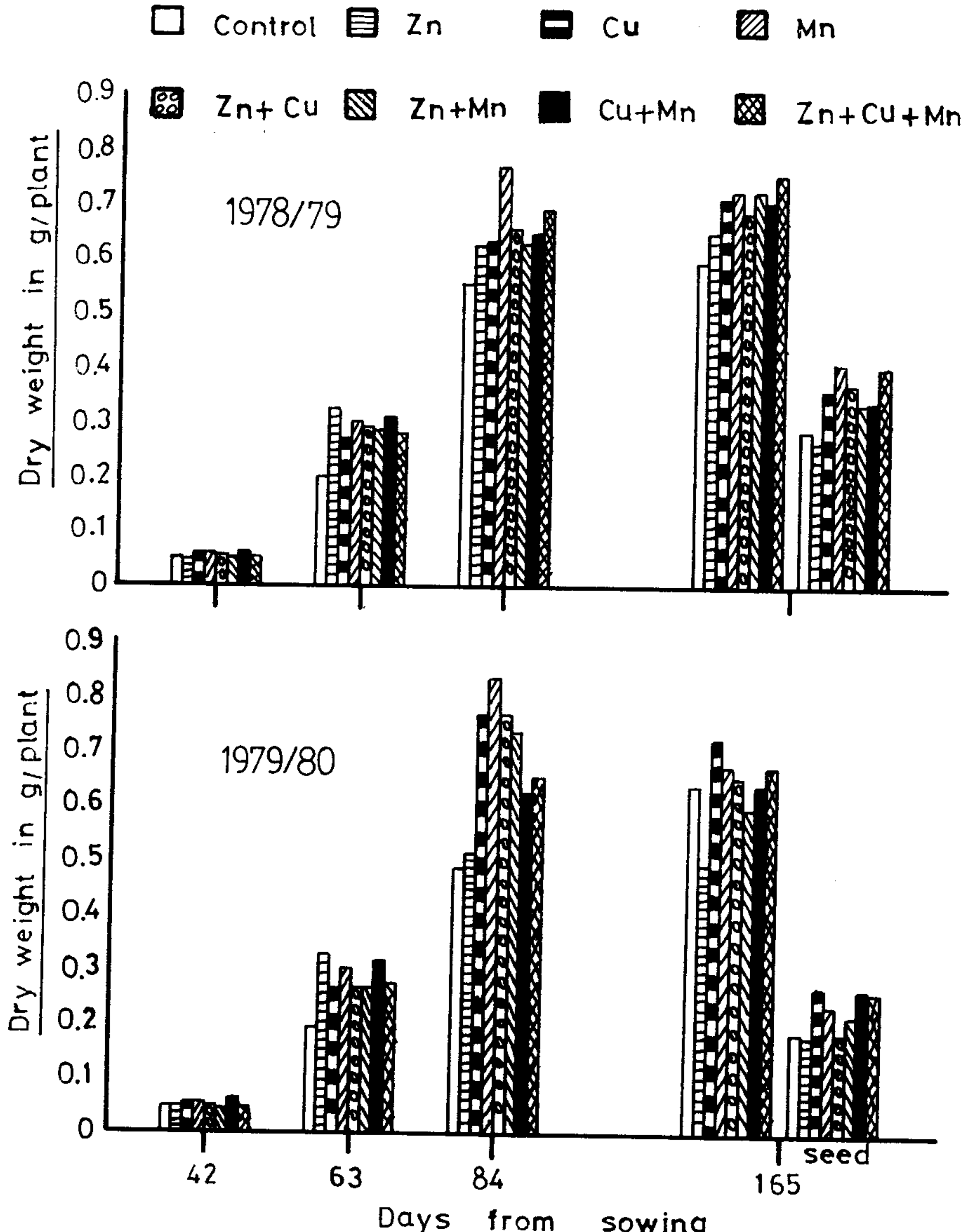

Fig.(2)- Effect of micro-nutrients on dry weight of flax (in g/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

II. Chemical Content

a. Nitrogen content

Data concerning the effect of N forms on N concentration as well as absolute amount of N (mg/plant) at different growth stages in 1978/79 and 1979/80 seasons are shown in Tables 16 and 17 and Figures 3 and 4.

1. Effect of nitrogen forms

Results showed that N concentration in flax plants decreased sharply and consistently with advanced growth.

The three N carriers used showed no clear difference in their effect on N concentration at the different stages of growth indicating that the three N forms were similar in affecting N concentration in flax plants.

Also, N percentage in flax seed was not clearly affected by N forms in both seasons. N percentage in seeds ranged from 3.38 % to 3.53 % in 1978/79 season and from 3.44 % to 3.63 % in 1979/80 season.

In regard to the absolute amount of N (mg/plant) it was clear from Table (17 that N forms had a significant effect on N content in both seasons.

At 42 days ammonium nitrate was significantly superior to the other two carriers in both seasons. With advanced growth urea showed better effect, where N content (mg/plant) significantly increased with urea application. That was clear at 63 and 84 days from sowing in both seasons.

At harvest, ammonium nitrate was superior in 1978/79, whereas urea ranked as first in 1979/80 season.

Similarly, maximum N content in seeds was obtained when ammonium nitrate was used in 1978/79 and with urea in 1979/80 season.

It could be concluded that no clear trend for the superiority of a certain N carrier was observed in regared to its effect on N content. Although results indicate a variable effect for N forms according to the stage of growth.

2. Effect of micro-nutrients

Data for the effect of micro-nutrients on N concentration as well as absolute amount of N (mg/plant) at different growth stages in 1978/79 and 1979/80 seasons are shown in Tables 16 and 17 and Figure 4.

Results showed that N percentage in flax was markedly affected by micro-nutrient application, where N percentage in plants increased as a result of micro-nutrient application. Best results were obtained when these elements were applied in combinations.

As for the N content as mg/plant, results showed that micro-nutrients significantly increased N uptake by flax plants in both seasons. At 84 days from sowing, the highest N uptake was achieved when Mn was applied. Other elements were also effective in increasing N uptake.

N content in flax seed (mg/plant) was favourably affected by micro-nutrient application in both seasons. A combination of more than one element gave better results.

Results reported by Fahmy and Sayed (1966) indicated that N content in flax was highest when Mn was applied, followed by Cu and Zn. Fahmy et al. also found in (1973) that Mn application increased chlorophyll a and b leading to a greater accumulation of N in flax plant.

3. Interaction effects

Results in Table 17 indicated that the interaction between N forms and micro-nutrients had a significant effect on N content (as mg/plant) at 63 and 165 days in 1978/79 season and at 63, 84 and 165 days in 1979/80 season.

Seed N content was also affected by this interaction in 1978/79 season.

At 63 days the highest N content was obtained when Cu + Mn were applied to flax treated with urea in both seasons. The lowest N content was obtained when no micro-nutrients were applied to plants fertilized by ammonium nitrate in both seasons.

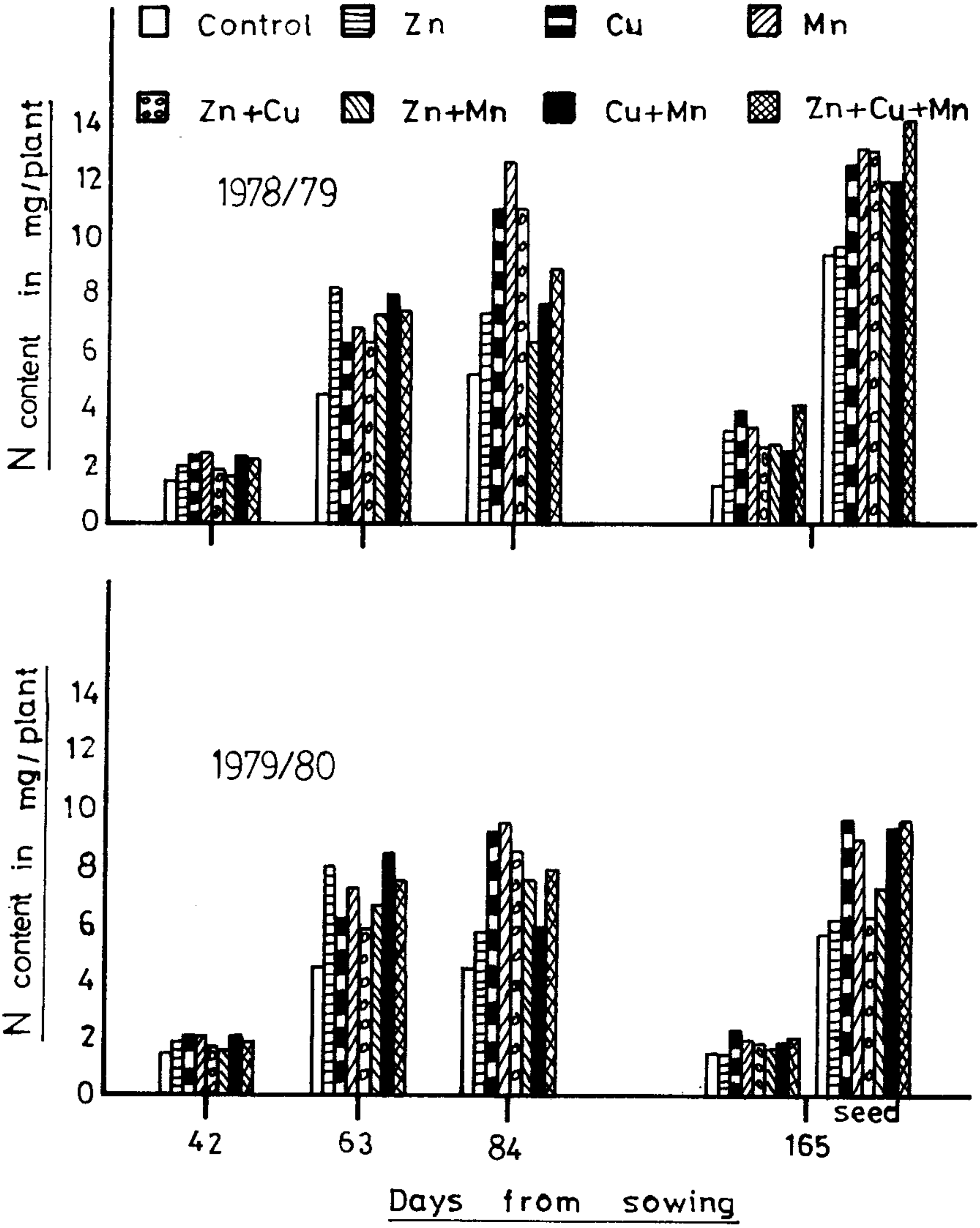

Fig.(4) - Effect of micro-nutrients on nitrogen content (in mg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

It was clear from Table 19 that ammonium nitrate induced greater P uptake atearly stages of growth (42 days from sowing). With advanced growth (at 63 days) the three forms were equally effective, and at 84 days ammonium sulphate was superior to the other carriers in the 1979/80 season. At harvesting time urea had the best effect in 1979/80 season and the three forms were of similar effect in 1978/79 season.

P content of seeds(as mg/plant) was significantly affected by N form in 1979/80 only where urea significantly increased P content in seeds compared with the other two forms.

In conclusion, N forms affected P uptake as a result of affecting dry weight/plant.

Results reported by El-Damaty and El-Kobbia (1958) showed that P content in flax seed was not affected by N application.

2. Effect of micro-nutrients

Results in Table 19 indicated that micro-nutrient application increased P percentage in flax at different growth stages as well as at harvest.

It is clear that P percentage decreased gradually with advanced growth reaching its minimum values at harvest as a result of seed formation.

Micro-nutrient application increased P percentage in seed only in 1978/79 season. Maximum increases were where Cu+ Mn and Cu were applied.

As for P uptake by flax (as mg/plant), micro-nutrients application significantly increased P content. Best results were obtained at 63 days where Zn was applied. With advanced growth (at 84 days) P content reached its maximum where Mn was applied alone or in combinations.

Generally, all micro-nutrients used induced greater P uptake compared with the control.

P content in seeds (as mg/plant) was significantly influenced by micro-nutrients. Maximum P contents in seeds w were when Cu andMn were used either alone or in combinations.

Results reported by Moraghan (1978) showed that P content in .flax was reduced by Zn application.

3. Interaction effects

Results in Table 19 indicated a significant interaction effect for N forms and micro-nutrients on P uptake by flax in both seasons.

At 63 days, the highest P content was where Zn + Mn were applied to plants fertilized with ammonium nitrate and the lowest P content was where no micro-nutrients was used to ammonium nitrate treated plants in 1978/79 season. In 1979/80 season, the maximum P content at 63 days was with Zn and ammonium sulphate and the minimum content was with no micro-

Table (18): Effect of nitrogen forms and micro-nutrients on the percentage of phosphorus in flax plant at different stages of growth in 1978/79 and 1979/80 seasons.

TREATMENTS	Sampling date (days from sowing)									
	42	63	84	165	165 Seed	42	63	84	165	165 Seed
	1978/79					1979/80				
$(NH_4)_2SO_4$	0.23	0.29	0.28	0.13	0.59	0.24	0.30	0.26	0.05	0.89
NH_4NO_3	0.25	0.29	0.29	0.17	0.50	0.28	0.27	0.20	0.05	0.86
$CO(NH_2)_2$	0.27	0.26	0.22	0.12	0.26	0.26	0.26	0.17	0.06	0.83
Control	0.24	0.24	0.19	0.06	0.43	0.23	0.25	0.19	0.05	0.87
Zn	0.24	0.30	0.26	0.08	0.48	0.23	0.30	0.19	0.09	0.84
Cu	0.25	0.28	0.28	0.11	0.60	0.25	0.27	0.19	0.06	0.84
Mn	0.22	0.26	0.28	0.07	0.52	0.27	0.25	0.22	0.05	0.86
Zn+Cu	0.26	0.29	0.28	0.10	0.56	0.27	0.28	0.23	0.06	0.88
Zn+Mn	0.26	0.31	0.23	0.13	0.51	0.27	0.31	0.19	0.05	0.89
Cu+MN	0.29	0.27	0.28	0.13	0.64	0.31	0.27	0.22	0.04	0.84
Zn+Cu+Mn	0.28	0.28	0.27	0.13	0.54	0.28	0.28	0.23	0.04	0.82

Table (19): Effect of nitrogen forms and micro-nutrients on phosphorus content (as mg/flax plant) at different stages of growth in 1978/79 and 1979/80 seasons.

TREATMENTS	Sampling date (days from sowing)																			
	42				63				84				165				165 seeds			
	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean
1978/79																				
Control	1.10	0.13	0.13	0.12 a	0.42	0.40	0.64	0.48 e	0.52	1.85	0.62	1.00 d	0.34	0.29	0. 2	0.35 e	1.43	1.24	0.94	1.20 c
Zn	0.09	0.12	0.14	0.12 a	0.99	0.99	0.92	0.97 a	1.67	1.84	1.37	1.63 bc	0.65	0.28	0.52	0.49 d	0.94	1.71	1.20	1.28 c
Cu	0.14	0.11	0.19	0.15 a	0.86	0.76	0.61	0.75 d	1.76	1.32	2.19	1.76 abc	1.27	0.09	0.99	0.78 bc	2.38	1.96	2.15	2.16 a
Mn	0.14	0.16	0.10	0.13 a	0.67	0.64	0.98	0.77 cd	1.60	2.76	1.98	2.11 a	2.17	0.60	0.45	0.50 d	1.76	2.51	2.15	2.14 a
Zn + Cu	0.15	0.16	0.11	0.14 a	0.71	0.69	1.02	0.81 bc	1.09	2.09	2.24	1.81 ab	0.41	1.13	0.45	0.66 cd	1.30	2.90	1.96	2.05 a
Zn + Mn	0.10	0.15	1.10	0.12 a	0.87	1.06	0.68	0.87 b	1.82	1.87	0.53	1.41 c	1.65	0.80	0.39	0.94 ab	1.69	1.91	1.52	1.71 b
Cu + Mn	0.14	0.25	0.13	0.18 a	0.83	0.66	0.99	0.83 bc	1.63	1.56	2.18	1.79 ab	0.81	1.27	0.72	0.90 a	1.55	2.82	2.24	2.20 a
Zn + Cu + Mn	0.11	0.20	0.11	0.14 a	0.99	0.62	0.75	0.79 cd	2.06	2.04	1.42	1.84 ab	0.46	0.82	1.62	0.97 a	1.66	2.80	1.93	2.13 a
MEAN	0.12 b	0.16 a	0.13 c		0.80 a	0.73 a	0.83 a		1.52 a		1.57 a		0.97 a	0.66 a	0.69 a		1.59 a	2.23 a	1.76 a	
L.S.D. A x B		n.s.				0.10				0.60				0.29				0.52		
1979/80																				
Control	0.09	0.11	0.12	0.11 a	0.44	0.40	0.62	0.49 d	1.02	0.87	0.86	0.92 b	0.16	0.32	0.37	0.28 cd	1.65	1.29	1.96	1.63 b
Zn	0.08	0.11	0.13	0.11 a	1.03	0.98	0.91	0.98 a	0.89	1.32	0.76	0.99 b	0.47	0.16	0.60	0.41 ab	1.55	1.07	2.04	1.55 b
Cu	0.13	0.11	0.15	0.13 a	0.83	0.70	0.61	0.71 c	1.59	1.41	1.38	1.46 ab	0.29	0.34	0.73	0.45 a	1.67	2.20	2.94	2.27 a
Mn	0.14	0.15	0.13	0.14 a	0.65	0.66	0.95	0.75 bc	2.13	1.61	1.56	1.77 a	0.24	0.25	0.47	0.32 bcd	1.57	1.57	2.86	2.00 ab
Zn + Cu	0.14	0.16	0.09	0.13 a	0.72	0.65	0.87	0.75 bc	2.17	2.03	1.09	1.76 a	0.27	0.30	0.58	0.38 ab	0.95	1.51	2.35	1.61 b
Zn + Mn	0.09	0.15	0.09	0.11 a	0.95	0.93	0.64	0.84 ab	1.75	0.82	1.48	1.35 ab	0.24	0.25	0.45	0.31 bcd	1.37	2.18	2.20	1.92 ab
Cu + Mn	0.14	0.25	0.11	0.17 a	0.86	0.67	0.98	0.84 abc	1.17	1.40	1.45	1.34 ab	0.18	0.39	0.27	0.28 cd	1.62	2.39	2.53	2.18 a
Zn + Cu + Mn	0.09	0.19	0.10	0.13 a	0.99	0.60	0.70	0.76 bc	2.24	1.42	0.88	1.51 ab	0.23	0.19	0.34	0.25 d	1.44	2.91	2.07	2.14 a
MEAN	0.11 b	0.16 a	0.11 b		0.81 a	0.70 a	0.79 a		1.62 a	1.36 b	1.18 b		0.26 b	0.27 b	0.48 a		1.48 c	1.89 b	2.37 a	
L.S.D. A x B		n.s.				0.04				n.d.				0.19				0.78		

L.S.D. at 5 % A x B = interaction between nitrogen forms and micro-nutrients.
n.s. = not significant.

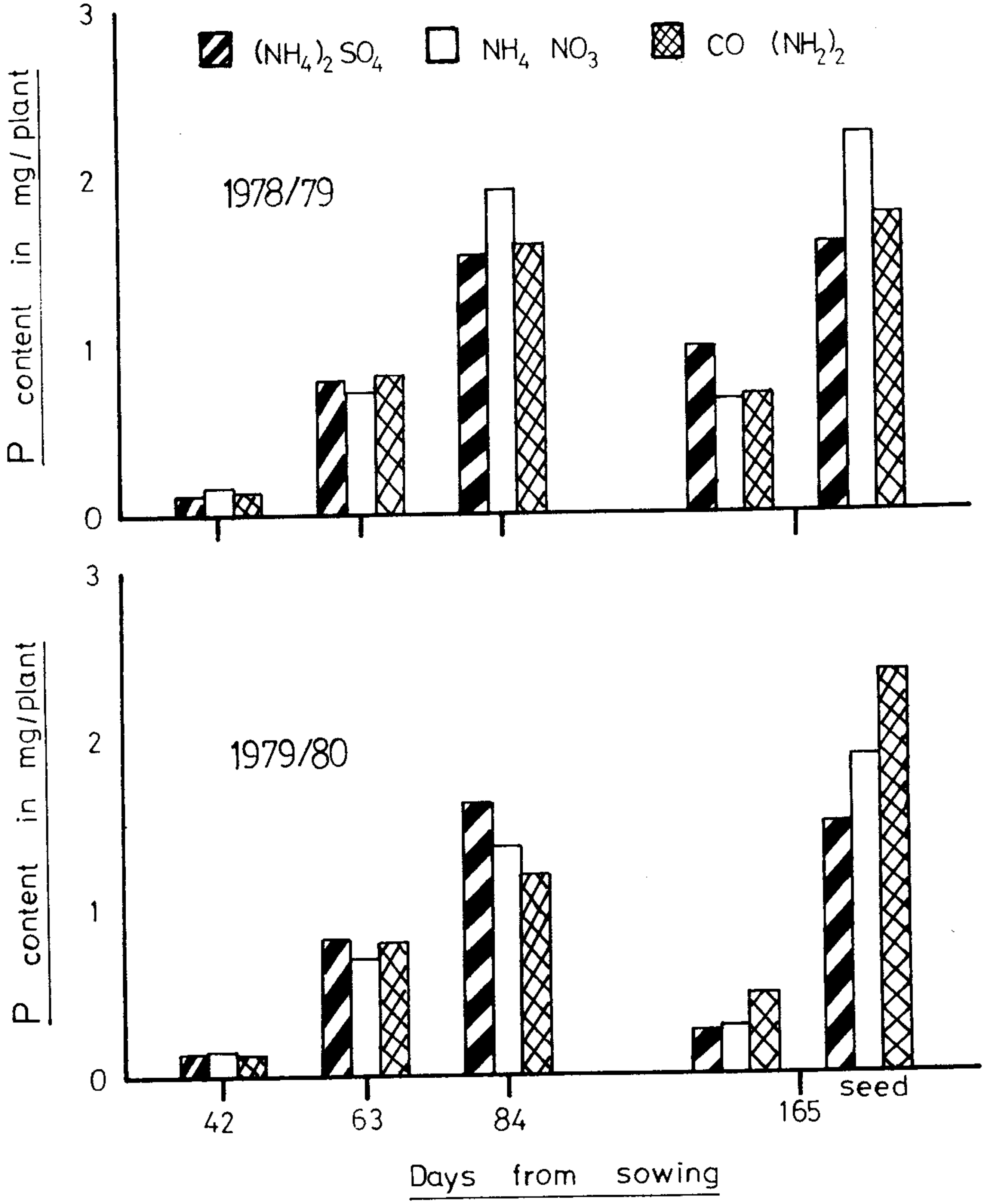

Fig (5) - Effect of nitrogen forms on phosphorus content (in mg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

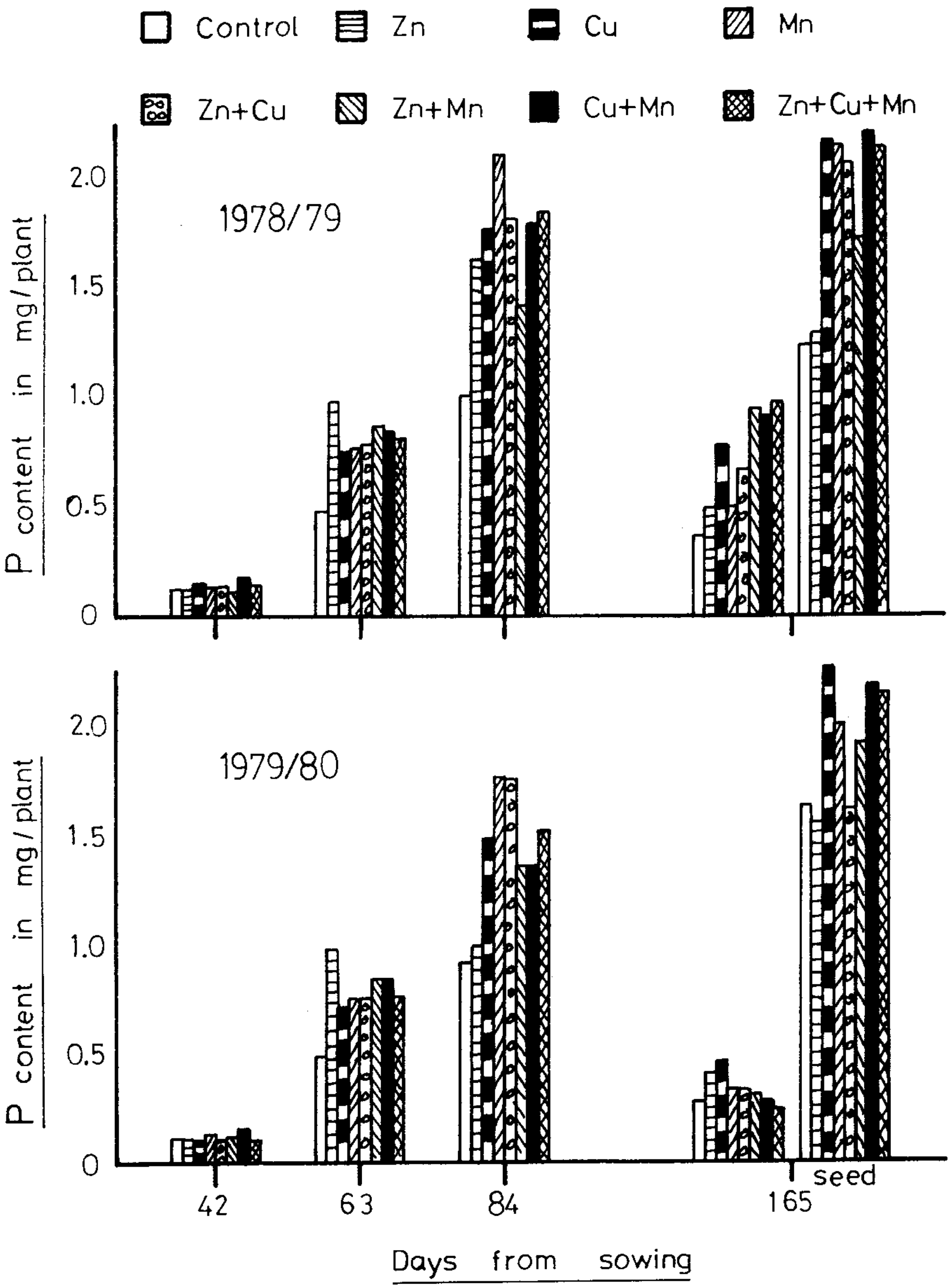

Fig.(6)-Effect of micro-nutrients on phosphorus content (in mg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

nutrient application and ammonium nitrate carrier.

Also P content (mg/plant) in seeds was significantly influenced by N forms x micro-nutrients interaction in both seasons. The highest P content in seeds was observed when Zn + Cu and ammonium nitrate were used in 1978/79 and with Mn and urea in 1979/80 season.

c. Potassium content

Data for the effect of N forms on K concentration as well as absolute amount of K (mg/plant) at different growth stages in 1978/79 and L979/80 seasons are shown in Tables 20 and 21 and Figures 7 and 8.

1. Effect of nitrogen forms

N forms showed no great effect on K percentage in flax at different growth stages in both seasons.

Also K concentration in flax seeds was about the same as a result of applying the three different forms.

The differences between the averages of K concentration due to different forms could not indicate a clear trend for the superiority of a certain N carrier.

In regard to K uptake by flax, results showed that N forms had a significant effect . Such significant effect was mainly due to the effect of N forms on dry weight/Plant.

It was clear from Table 21 that ammonium nitrate was more effective at early stage of growth (42 days). With advanced growth (at 63 and 84 days) the three N forms were of similar effect on K uptake in both seasons. At harvest, ammonium nitrate induced higher K uptake in 1978/79 while urea was the best carrier in this respect in 1979/80.

K content of seeds (as mg/plant) was significantly affected by N forms. Ammonium nitrate was superior in 1978/79 season and urea was more effective in 1979/80.

In conclusion N forms affected K uptake as a result of affecting dry weight/plant.

El Damaty and El-Kobbia (1958) stated that K content in flax seeds was not influenced by nitrogen application.

2. <u>Effect of micro-nutrients</u>

Results in Table 21 indicated that micro-nutrients had no great effect on K percentage in both seasons.

It is clear that K percentage decreased gradually with advanced growth reaching its lowest value at harvest as a result of K translocation into the seeds.

The micro-nutrient treatments had no effect on K percentage in flax seeds in 1978/79 and 1979/80 as well. However, the highest percentages were with Cu + Mn (0.99 %) in 1978/79 season and ZN + Mn (0.84 %) in 1979/80 season.

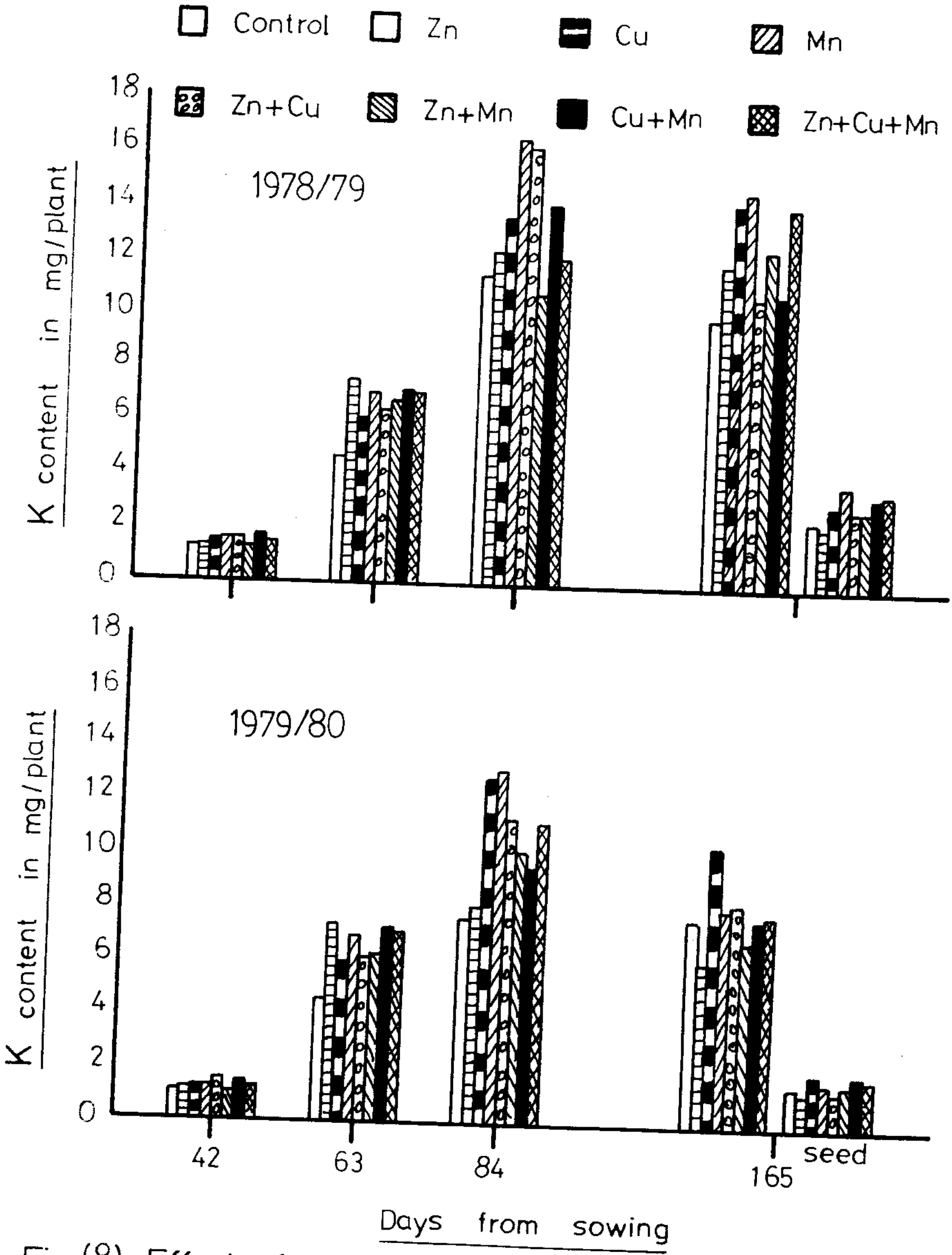

Fig.(8)- Effect of micro-nutrients on potassium content (in mg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

d. Zinc content

Data for the effect of N forms and micro-nutrients on Zn concentration (ppm), as well as the absolute amount of Zn (ug/plant) at different growth stages in 1978/79 and 1979/80 seasons are shown in Tables 22 and 23 and Figures 9 and 10.

1. Effect of nitrogen forms

Data revealed that Zn concentration gradually decreased with the advance in plant age. The highest values were recorded at the first sample.

Results showed that N forms had no clear effect on Zn concentration (as ppm) in flax at early stages as well as at later stages of growth. It was observed that ammonium nitrate and ammonium sulphate gave the best effect at 165 days from sowing, whereas Zn concentration was higher in plants treated with ammonium nitrate in both seasons.

As for Zn uptake by flax (as ug/plant) the results showed that N forms affected significantly Zn content at different stages. In general, ammonium nitrate had better effect at 42 as well as at 165 days from sowing, whereas urea favourably affected Zn content at 63 days in both seasons.

Zn content in flax seed was significantly effected by N forms in 1978/79 season only, where ammonium nitrate induced Zn uptake compared with the other two carriers.

In conclusion, N forms affected Zn uptake by plants through affecting dry matter accumulation in plant.

2. Effect of nmicro-nutrients

Zn concentration in flax was clearly affected by Zn application in both seasons and at different growth stages.

At 165 days , the highest Zn concentrations were for plants treated with Zn + cu in 1978/79and Zn + Mn in 1979/80.

As for Zn content (as ug/plant), results showed that in 1978/79 season significantincreases in Zn content were only recorded at 165 days as a result of combining Zn application with Cu.

In 1979/80 season, Zn content at different growth stages increase significantly when Zn was applied with Cu and / or Mn.

Zn content in seeds was also affected by micro-nutrient application in both seasons. The highest Zn content in seeds was observed when Mn and Zn + Cu + Mn were used in 1978/79 season and when Cu and Mn were applied either alone or in combination with in . 1979/80 season.

In conclusion, micro-mutrient application induced in general Zn uptake by flax.

Shchetinina and Chepikov (1966) reported that flax plants absorbed micro-nutrients throughout the vegetative period and that Cu resulted in increasing the uptake of Zn.

Also Porokhnevich (1976) showed that the addition of Zn and Cu caused an increase in Zn and Cu levels in seeds.

3. Interaction effects

Results indicated that Zn content in flax was significantly affected by the interaction between N forms and micro-nutrients at 63 and 165 days in 1978/79 and at 63, 84 and 165 days in 1979/80 season (Table 23).

Also Zn content in seeds was significantly affected by the interaction between N forms and micro-nutrients in 1978/79 season only.

In 1978/79, it was observed that at 63 days, the highest Zn content was obtained when Zn + Cu were applied to plants, treated with wurea and the lowest Zn content was observed when no micro-nutrients were applied to plants fertilized with ammonium nitrate.

In 1979/80 season, the highest Zn content at 63 days was obtained when Mn was applied to plants treated with urea and lowest content was when no micro-nutrients were applied to plants treated with ammonium nitrate.

At 165 days, the highest Zn content was shown when Zn + Cu were applied to plants treated with urea in both .
[illegible]

seasons and lowest Zn contents were when nc micro-nutrients were applied to plants treated with urea in1978/79 and ammonium nitrate in 1979/80.

e. Copper content

Data for the effect of N forms and micro-nutrients on Cu concentration (ppm) as well as absolute amount of Zn (ug/plant) at different growth stages in 1978/79 and 1979/80 seasons are shown in Tables 24 and 25 and Figures 11 and 12.

1. Effect of nitrogen forms

Data revealed that Cu concentration was apparently affected by N forms in both seasons.

At early stage of growth (42 days from sowing) ammonium nitrate was superior to the other two carriers in inducing Cu uptake by flax. With advanced growth ammonium sulphate showed better effect, particularly at 63 and 84 days from sowing, and at harvesting time ammonium nitrate was more effective.

Cu concentration in flax seeds was highest when urea was the nitrogen carrier in both seasons, followed by ammonium sulphate, whereas the lowest Cu concentration was when ammonium nitrate was used.

As for Cu content (as ug/plant) it was evident that N forms showed significant effect in both seasons. In general, Table (22): Effect of nitrogen forms and micro-nutrients on the concentration of Zn (ppm) in flax plant at different stages of growth in 1978/79 and 1979/80 seasons.

TREATMENTS	Sampling date (days from sowing)									
	42	63	84	165	165 seed	42	63	84	165	165 seed
	1978/79					1979/80				
$(NH_4)_2SO_4$	94.2	75.1	80.8	58.1	76.6	93.5	81.3	54.0	34.1	76.7
NH_4NO_3	93.7	74.0	69.0	59.7	70.2	94.8	72.7	48.3	45.0	83.6
$CO(NH_2)_2$	89.8	73.7	71.4	56.9	66.0	88.4	77.6	33.7	34.4	75.6
Control	103.9	70.9	76.3	46.1	88.6	104.3	72.2	33.5	24.0	73.3
Zn	96.0	73.4	87.7	58.3	71.8	93.6	82.6	44.6	40.0	75.5
Cu	86.7	76.3	88.2	63.1	72.8	86.5	75.9	47.1	43.5	80.2
Mn	95.0	74.6	62.8	60.3	72.2	96.2	80.9	45.1	31.7	77.7
Zn+Cu	89.1	76.4	81.6	70.0	62.6	87.8	80.6	39.3	43.5	79.5
Zn+MN	95.7	71.0	66.6	53.3	58.7	95.1	72.4	53.7	51.3	83.5
Cu+Mn	93.6	74.6	64.6	52.4	71.2	92.7	75.3	44.1	43.5	80.0
Zn+Cu+Mn	90.2	76.6	62.2	62.1	67.9	89.4	83.9	49.9	31.8	77.8

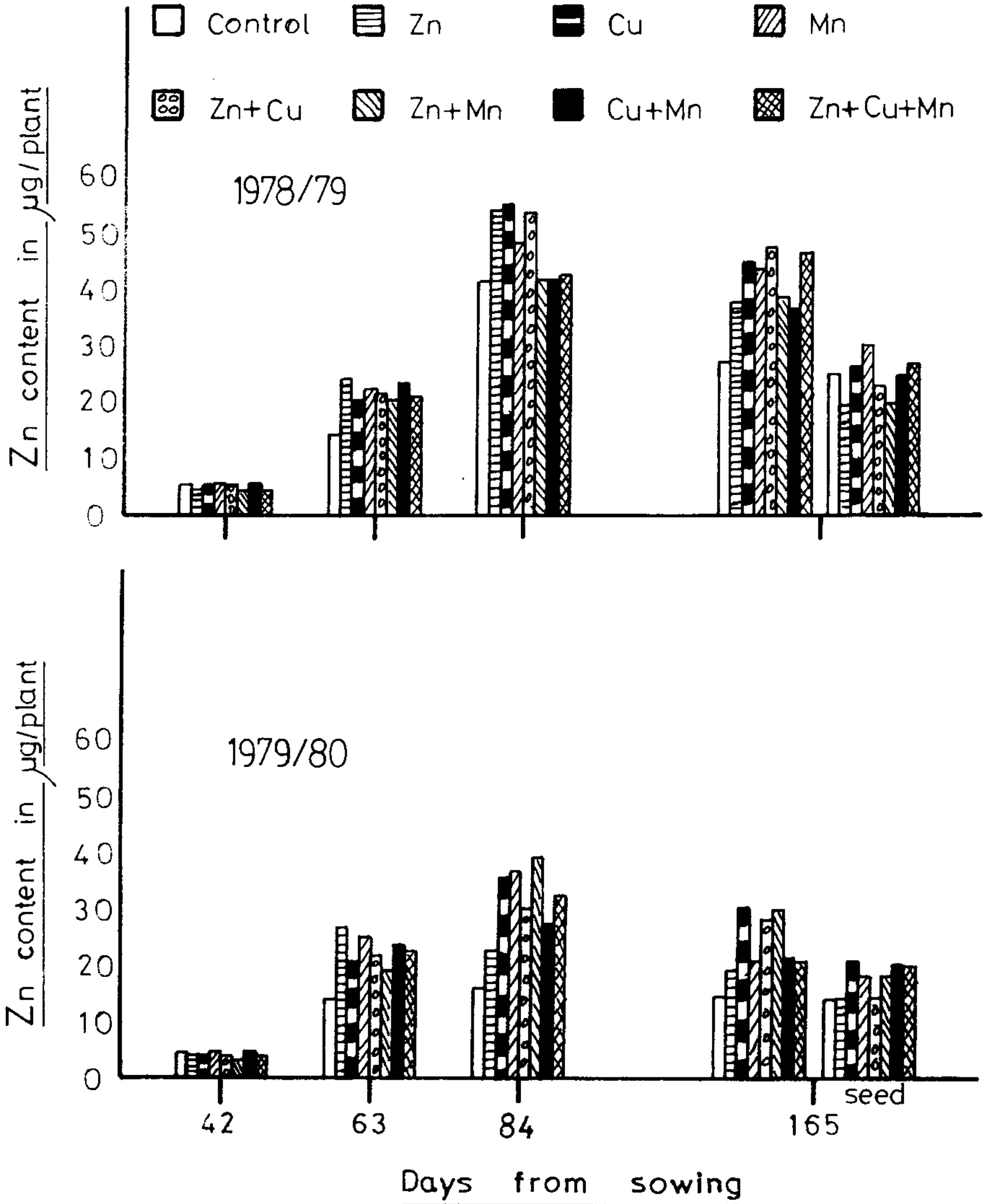

Fig.(10)-Effect of micro-nutrients on zinc content (in µg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

ammonium nitrate encouraged Cu uptake at 42 days in both seasons, whereas at 63 . and 84 days the three carriers were nearly of similar effect.

At harvesting time ammonium nitrate was significantly superior in 1978/79 and urea was more effective in 1979/80 where highest Cu uptake was recorded.

As for Cu content (as ug/plant seed) highest content was when urea [redacted] used in both seasons.

It could be concluded that ammonium nitrate and urea encouraged Cu uptake by flax.

Results reported by Reuther (1957) indicated that plants receiving ammonium N responded to higher levels of Cu than did plants receiving nitrate N, implying that Cu was concerned with the utilization of ammonium N by plant.

2. <u>Effect of micro-nutrients</u>

Micro-nutrient application markedly increased Cu concentration throughout the growing season.

The highest concentration were observed when Cu was applied alone or in combinations with Zn and Mn.

Also Cu concentration in flax seed markedly increased with micro-nutrient application. The highest Cu concentration in seeds was obtained when Cu + Zn were applied in both seasons.

It could be concluded that micro-nutrients in general and those including Cu in particular resulted in increasing Cu concentration in flax throughout the growth stages.

Regarding Cu content (as ug/plant), results indicated that micro-nutrient treatments in general and those including the three elements (Zn + Cu + Mn) in particular induced a greater Cu uptake at early as well as at later stages of growth.

It is evident from Table 25 that the highest Cu contents were 14.8 ug/plant in 1978/79 and 13.8 ug/plant in 1979/80 and were achieved when Zn + Cu + Mn were applied.

Also, Cu content in seeds was greatly affected by micro-nutrient application.The highest Cu contant was obtained when Cu and Mn were applied either alone or in combination.

It could be concluded that micro-nutrients in general and Cu in particular markedky influenced Cu uptake by flax.

Results reported by Porokhnevich (1976) indicated t that the addition of Zn and Cu increased levels of Zn and Cu in flax seed.

3. Interaction effects

Results showed that Cu uptake by flax was significantly affected by the interaction between N forms and micronutrients at 63, 84 days and 105 days in 1978/79 season and at 63 and 84 days in 1979/80 season.

At 63 days, the highest Cu content was obtained when Zn was applied with urea in both seasons and the lowest content was observed when no micro-nutrients were applied to plants fertilized with ammonium nitrate in both seasons.

Also, Cu content in seeds was influenced by N forms X micro-nutrients in both seasons. The highest Cu content in seeds was obtained when Mn was applied to plants feretlized with urea in both seasons.

f. Manganese content

Data for the effect of N forms and micro-nutrients on Mn concentration (ppm) as well as absolute ammount of Mn (ug/plant) at different growth stages in 1978/79 and 1979/80 are shown in Tables 26 and 27 and Figures 13 and 14.

1. Effect of nitrogen forms

Data revealed that Mn concentration gradualy decreased with advance in plant age. The highest values were redorded at the first sample.

Results indicated that N forms had no marked seffect on Mn concentration in both seasons. No clear trend could be detected for the superiority of a certain N form throughout the two growing seasons.

As for Mn content (as ug/plant), results showed that ammonium nitrate was more effective at 42 and 84 days in both

Table (24): Effect of nitrogen forms and micro-nutrients on the concentration of Cu (ppm) in flax plant at different stages of growth in 1978/79 and 1979/80 season

TREATMENTS	Sampling date (days from sowing)									
	42	63	84	165	165 seed	42	63	84	165	165 seed
	1978/79					1979/80				
$(NH_4)_2SO_4$	15.4	21.7	15.9	15.5	10.4	13.0	19.1	23.9	16.1	18.0
NH_4NO_3	23.8	19.3	12.9	17.1	9.6	24.1	18.4	17.4	17.5	16.4
$CO(NH_2)_2$	18.4	17.4	13.3	12.2	17.5	18.6	16.6	21.7	17.3	19.5
Control	11.8	15.8	12.2	9.7	11.7	12.8	14.1	20.6	13.7	14.4
Zu	24.0	19.3	13.0	11.8	11.9	23.4	17.1	20.7	17.2	17.9
Cu	11.7	25.6	13.4	16.7	10.0	11.5	23.0	23.6	15.4	19.3
Mn	15.0	22.1	13.6	14.2	12.2	13.5	20.5	28.4	14.4	20.1
Zn+Cu	27.3	16.2	14.1	14.5	13.7	14.1	16.1	17.7	15.4	21.3
Zn+Mn	15.2	19.8	10.5	15.9	12.6	17.1	18.3	18.3	18.1	17.1
Cu+Mn	22.6	17.0	14.7	18.4	13.4	21.8	16.4	13.8	21.7	15.7
Zn+Cu+Mn	27.5	18.0	19.2	19.8	11.4	27.7	18.3	22.0	20.6	18.1

Table (25): Effect of nitrogen forms and micro-nutrients on Cu content (as ug/flax plant) at different stages of growth in 1978/79 and 1979/80 seasons.

TREATMENTS	Sampling date (days from sowing)																			
	42				63				84				165				165 seed			
	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean
1978/79																				
Control	0.6	0.6	0.6	0.6 a	4.0	2.5	2.9	3.2 f	7.5	3.8	8.5	6.6 d	4.0	7.8	5.3	5.7 e	4.1	3.7	2.2	3.3 d
Zn	1.1	1.4	1.2	1.2 a	8.0	3.2	7.7	6.3 b	8.4	8.9	6.8	8.0 cd	7.2	8.5	7.1	7.6 d	2.6	3.9	3.3	3.2 d
Cu	0.5	0.8	0.8	0.7 a	7.3	6.8	6.6	6.9 a	8.6	7.7	8.9	8.4 bcd	12.4	14.2	8.9	11.8 b	4.5	3.1	3.2	3.6 cd
Mn	1.4	0.6	0.6	0.9 a	8.5	6.6	4.7	6.6 ab	9.8	8.5	12.9	10.4 b	8.7	17.5	2.2	10.2 c	2.0	3.4	9.7	5.0 a
Zn + Cu	0.7	2.6	1.1	1.5 a	4.8	4.1	5.0	4.6 e	9.6	12.1	6.0	9.3 bc	7.9	17.1	4.3	9.8 c	3.2	4.8	7.0	5.0 a
Zn + Mn	0.5	0.9	0.8	0.7 a	4.6	7.3	4.9	5.6 c	6.1	3.6	10.3	6.6 d	9.5	16.2	8.5	11.4 bc	2.1	4.3	6.0	4.2 bc
Cu + Mn	0.7	2.1	1.4	1.4 a	4.5	4.7	6.8	5.3 cd	6.8	8.3	13.3	9.5 bc	11.4	21.1	6.1	12.9 b	1.8	5.2	6.7	4.6 ab
Zn + Cu + Mn	0.7	2.6	0.8	1.4 a	6.1	3.9	5.0	5.0 de	13.4	15.5	10.0	13.0 a	11.6	20.9	11.9	14.8 a	2.0	6.1	5.6	4.5 ab
MEAN	0.8 b	1.5 a	0.9 c		6.0 a	4.9 b	5.5 ab		8.8 a	8.5 a	9.6 a		9.1 b	15.4 a	7.0 b		2.8 c	4.3 b	5.5 a	
L.S.D. A X B	n.s.				0.7				3.3				2.7				0.7			
1979/80																				
Control	0.6	0.7	0.6	0.6 a	3.4	2.1	2.9	2.8 c	6.3	13.6	10.1	10.0 de	3.8	7.1	14.5	8.5 b	2.0	2.1	3.9	2.7 d
Zn	1.0	1.2	1.1	1.1 a	6.2	2.8	7.6	5.5 ab	7.5	15.7	8.9	10.7 cde	6.3	7.0	11.7	8.3 b	3.6	1.7	4.7	3.3 cd
Cu	0.4	0.7	0.7	0.6 a	5.1	6.8	6.5	6.1 a	24.4	14.4	15.1	18.0 b	6.7	13.1	13.5	11.1 ab	3.7	4.1	7.9	5.2 a
Mn	1.2	0.5	0.5	0.7 a	7.6	7.0	3.7	6.1 a	28.0	8.6	33.8	23.4 a	11.8	7.4	9.5	9.6 ab	3.8	2.4	8.0	4.7 ab
Zn + Cu	0.6	2.5	1.0	1.4 a	5.1	4.0	3.8	4.3 b	17.0	10.3	13.1	13.5 bcd	10.1	5.1	14.8	10.0 ab	2.2	3.0	6.4	3.9 bcd
Zn + Mn	0.5	0.8	0.7	0.7 a	4.2	6.3	4.4	4.9 ab	12.3	7.0	20.6	13.3 bcd	9.5	8.6	13.9	10.7 ab	2.5	4.4	4.2	3.7 bc
Cu + Mn	0.4	2.0	1.3	1.2 a	4.3	4.7	6.2	5.1 ab	8.5	8.0	9.1	8.5 e	10.6	10.9	19.6	13.7 a	2.6	3.8	5.9	4.1 abc
Zn + Cu + Mn	0.6	2.5	0.8	1.3 a	5.5	4.1	6.2	5.0 ab	16.5	17.7	8.6	14.3 bc	7.5	18.8	15.0	13.8 a	3.5	7.1	3.6	4.7 ab
MEAN	0.6 b	1.4 a	0.8 b		5.2 a	4.7 a	5.1 a		15.1 a	11.9 a	14.9 a		8.3 b	9.7 b	14.1 a		3.0 b	3.6 b	5.6 a	
L.S.D. A x B	n.s.				0.7				7.5				n.s.				2.1			

L.S.D. at 5 % A x B = interaction between nitrogen forms and micro-nutrients.
n.s. = not significant.

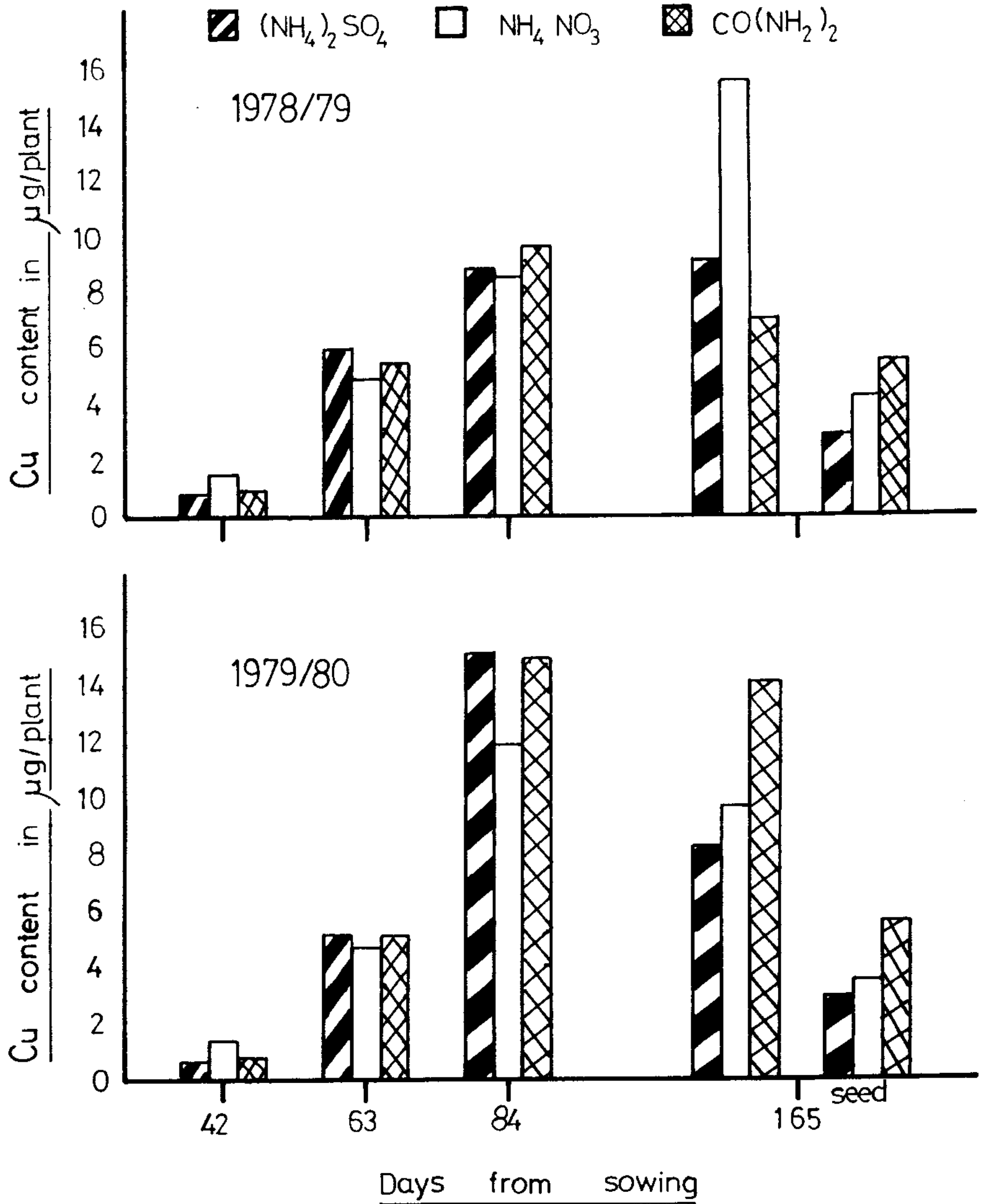

Fig.(11)- Effect of nitrogen forms on copper content (in µg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

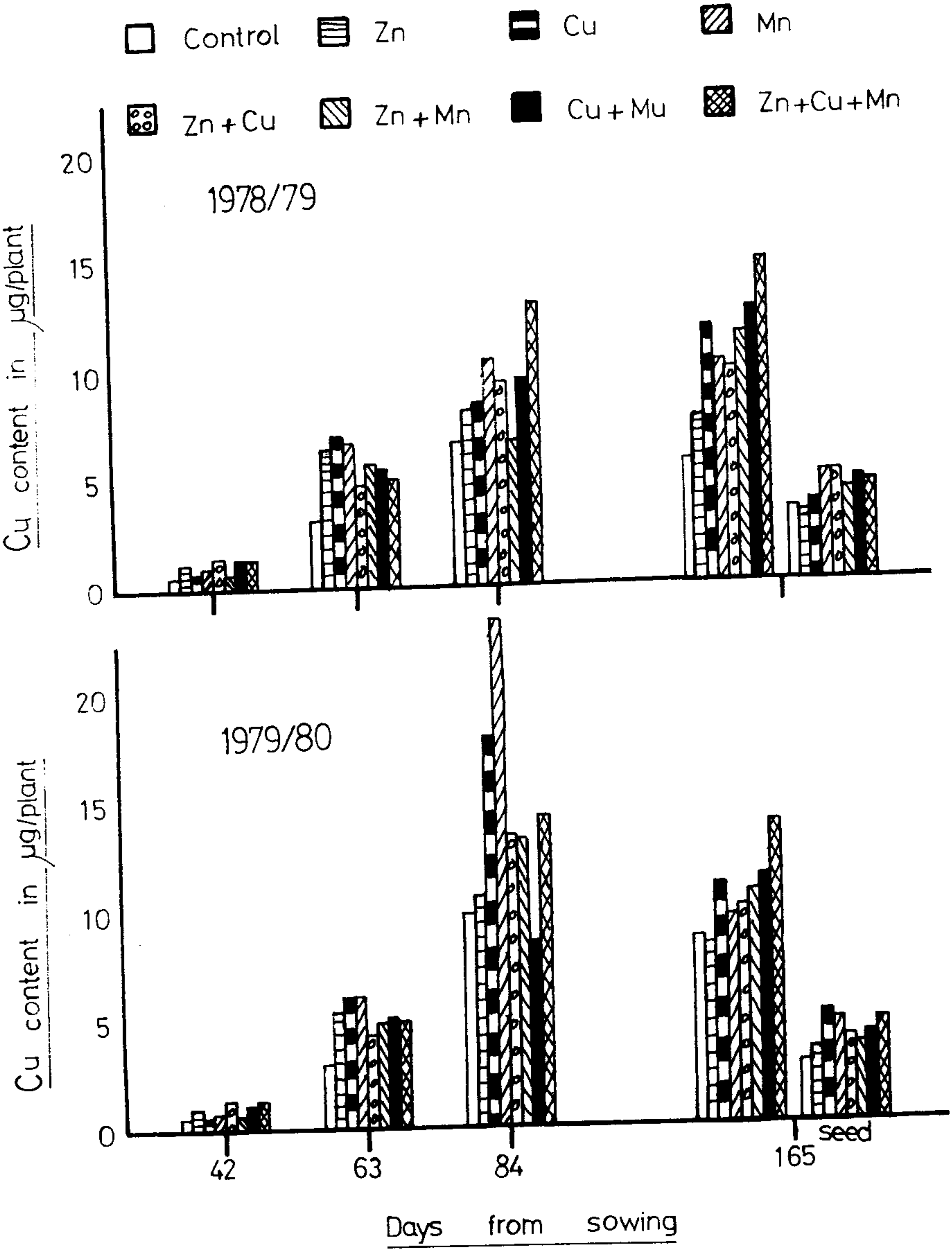

Fig.(12)- Effect of micro-nutrients on copper content (in µg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

seasons and at 165 days in 1978/79 seaon.

Also the highest Mn content in seeds (as ug/plant) was recorded when ammonium nitrate was used in both seasons.

Such results indicate that ammonium nitrate encouraged Mn uptake by flax plants in both seasons.

2. Effect of micro-nutrients

Results showed that micro-nutrient application increased Mn concentration in flax at different growth stages as well as in both seasons.

All micro-nutrient treatments induced higher Mn content as compared with the untreated plants.

The highest Mn concentration were recorded when Mn was applied either alone or in combination with Zn and Cu.

Similarly, Mn concentration in seeds markedly increased with micro-nutirent application in general and with combinations including Mn in particular.

As for Mn content (as ug/plant) results showed that micro-nutrient treatments significantly increased Mn uptake by flax at different growth stages as well as in both seasons.

The highest Mn contents were generally recorded when Mn was combined with Zn and / or Cu.

Also flax seeds contained higher Mn contents as a result of applying micro-nutrient combinations. It is evident that micro-nutrient treatments were superior to the control treatment in regard to Mn content in flax seeds.

Results reported by Shchetinina and Chepikov (1966) showed that flax plants observed micro-elements throughout the vegetative period.

3. Interaction effects

Rsults indicated that in 1978/79 season the interaction between N forms and micro-nutrients had significant effect on Mn content in flax at 63, 84 and 165 days form sowing.

In 1979/80 season, the interaction between N forms and micro-nutrients significantly affected Mn content only at harvest (at 165 days).

In 1978/79 season the highest Mn uptake at 63 days was obtained, when Zn + Cu + Mn were applied to plants fertilized with ammonium sulphate. The lowest content was observed when no micro-nutrients were applied to plants which fertilized with ammonium sulphate.

At 165 days, the highest Mn contents were obtained when Mn was applied to plants treated with ammonium nitrate in 1978/79 and when Zn + Cu were applied to plants treated with urea in 1979/80 season.

Results showed that Mn content (as ug/plant) in flax seeds was ..significantly affected by the interaction between N forms and micro-nutrients in both seasons. The highest Mn content was obtained when Zn + Cu + Mn were applied to plants fertilized with ammonium nitrate.

The lowest Mn contents were noticed when ammonium sulphate was combined with Zn application in 1978/79 season and when Zn + Cu were used with the same N carrier in 1979/80 season.

Table (26): **Effect of nitrogen forms and micro-nutrients on the concentration of Mn (ppm) in flax plant** at different stages of growth in 1978/79 **and** 1979/80 seasons.

TREATMENTS	Sampling date (days from sowing)									
	42	63	84	165	165 seed	42	63	84	165	165 seed
			1978/79					1979/80		
$(NH_4)_2SO_4$	171.2	144.0	67.4	61.0	17.5	163.0	132.2	42.2	38.8	71.3
NH_4NO_3	165.1	123.6	62.6	63.4	17.3	165.5	120.3	55.2	57.7	86.8
$CO(NH_2)_2$	157.1	114.2	53.7	29.0	19.4	165.1	120.1	45.9	72.6	61.0
Control	111.8	127.6	40.6	57.4	17.4	131.9	129.8	41.4	40.2	46.0
Zn	190.0	120.2	54.8	67.9	17.5	185.1	117.7	43.0	68.3	88.6
Cu	163.3	114.1	53.0	74.5	19.7	169.2	107.1	46.4	64.4	70.4
Mn	186.7	130.1	78.4	57.9	17.4	180.8	133.2	55.8	57.3	59.4
Zn+Cu	145.5	114.8	68.3	56.4	17.5	142.9	112.7	50.0	72.8	52.5
Zn+Mn	163.0	147.4	60.2	58.2	20.1	148.8	136.2	43.0	57.4	83.3
Cu+MN	177.4	110.0	62.3	58.3	17.4	174.6	121.8	48.9	53.6	90.0
Zn+Cu+Mn	188.2	154.3	60.2	41.94	17.5	185.1	152.4	50.4	58.2	78.1

Table (27): Effect of nitrogen forms and micro-nutrients on Mn content (as ug/flax plant) at different stages of growth in 1978/79 and 1979/80 seasons.

TREATMENTS	Sampling date((days from sowing)																			
	42				63				84				165				165 seed			
	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean	$(NH_4)_2SO_4$	NH_4NO_3	$CO(NH_2)_2$	Mean
1978/79																				
Control	5.9	5.5	5.8	5.7 a	23.4	25.6	28.7	25.9 f	8.0	21.8	35.9	21.9 d	21.6	53.2	26.18	33.66 cd	4.6	5.9	4.2	4.9 d
Zn	7.2	11.2	10.2	9.5 a	44.2	37.2	36.5	39.3 bc	16.5	45.2	39.5	33.8 c	24.7	78.3	28.84	43.95 b	2.8	6.1	5.1	4.7 d
Cu	10.0	10.3	9.0	9.8 a	33.7	32.2	26.6	30.8 e	14.9	42.4	42.1	33.1 c	58.2	71.9	28.23	52.78 a	5.8	7.9	7.5	7.1 a
Mn	10.9	14.9	8.0	11.2 a	44.5	27.2	45.1	38.9 c	76.2	56.5	47.7	60.1 a	31.3	63.6	29.73	41.54 bc	5.1	8.9	7.3	7.1 a
Zn + Cu	6.7	10.5	6.9	8.0 a	32.2	28.3	37.4	32.6 de	45.0	43.5	46.6	45.0 b	27.4	57.1	29.77	38.09 bcd	3.8	9.4	6.0	6.4 bc
Zn + Mn	8.1	8.9	5.6	7.5 a	45.3	41.5	38.2	41.7 ab	43.4	39.3	30.4	37.7 bc	43.5	53.9	28.30	41.90 b	5.5	6.8	7.72	6.7 ab
Cu + Mn	12.9	11.4	8.6	11.0 a	37.3	25.0	40.4	34.2 d	37.6	44.0	39.2	40.3 bc	39.4	55.4	28.20	41.00 bc	4.7	8.2	5.08	6.0 c
Zn + Cu + Mn	9.8	11.0	7.9	9.6 a	58.3	34.3	36.1	42.9 a	56.3	36.8	29.5	40.8 bc	40.1	23.5	33.40	34.33 d	5.1	9.5	6.01	6.9 ab
MEAN	8.9 c	10.4 a	7.7 b		39.9 a	31.4 b	36.1 a		37.2 a	41.2 a	38.9 a		36.2 b	57.4 a	29.0 c		4.7 b	7.8 a	6.10 ab	
L.S.D. A x B	n.s.				4.2				14.1				6.4				1.7			
1979/80																				
Control	5.6	5.3	7.7	6.2 a	23.0	25.9	28.0	25.7 d	10.7	30.6	18.9	20.1 c	9.8	24.3	40.9	25.0 c	7.3	10.3	8.3	8.6 d
Zn	6.7	1.3	9.3	8.7 a	38.2	38.0	37.5	37.9 ab	13.6	29.1	23.9	22.2 c	15.9	26.3	56.7	33.00 bc	18.3	11.5	19.2	16.3 bc
Cu	9.2	9.7	7.7	8.8 a	29.3	29.8	26.0	28.38 cd	32.3	44.8	29.1	35.4 ab	23.9	49.6	65.5	46.3 ab	10.8	21.2	25.1	19.0 ab
Mn	8.2	12.9	7.2	9.4 a	41.1	31.2	46.8	39.7 a	35.8	45.4	56.6	45.9 a	22.9	42.9	48.4	38.1 abc	14.3	15.6	11.9	13.9 cd
Zn + Cu	5.6	9.9	5.6	7.0 a	30.1	27.0	33.6	30.2 bcd	30.8	53.2	30.5	38.2ab	15.8	28.1	98.2	47.3 a	6.3	10.9	11.6	9.6 d
Zn + Mn	5.2	8.1	4.9	6.1 a	41.1	34.6	33.8	36.5 abc	20.7	33.2	39.9	31.3 bc	23.9	28.8	49.1	33.9 abc	11.5	24.5	18.2	18.0 bc
Cu + Mn	10.5	10.9	7.3	9.6 a	37.6	26.2	50.2	38.0 ab	25.0	31.5	34.0	30.1 bc	26.9	26.6	48.2	33.9 abc	14.3	25.0	31.2	23.5 a
Zn + Cu + Mn	8.7	10.1	7.4	8.7 a	54.3	33.6	37.0	41.6 a	44.8	34.3	19.2	32.7 bc	20.6	30.5	65.5	38.9 ab	12.7	33.9	14.4	20.3 ab
MEAN	7.5 a	9.6 a	7.1 b		36.1 a	30.8 a	37.0 a		26.7 a	37.8 a	31.5 a		20.0 a	32.1 a	59.1 a		11.9 b	19.1 a	17.5 c	
L.S.D. A x B	n.s.				n.s.				n.s.				21.3				7.9			

L.S.D. at 5 % A x B = interaction between nitrogen forms and micro-nutrients.
n.s. = not significant.

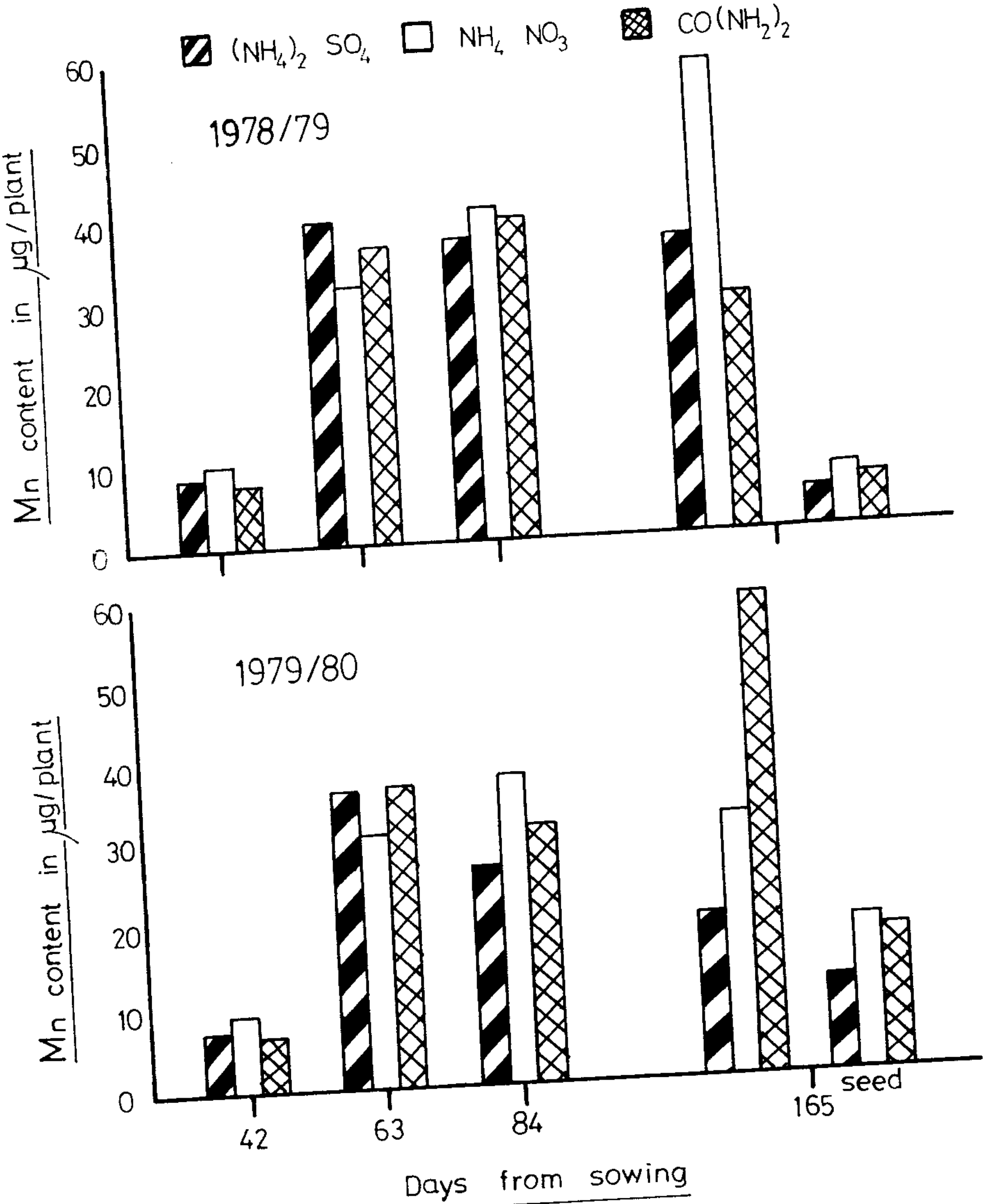

Fig.(13)- Effect of nitrogen forms on manganese content (in µg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.

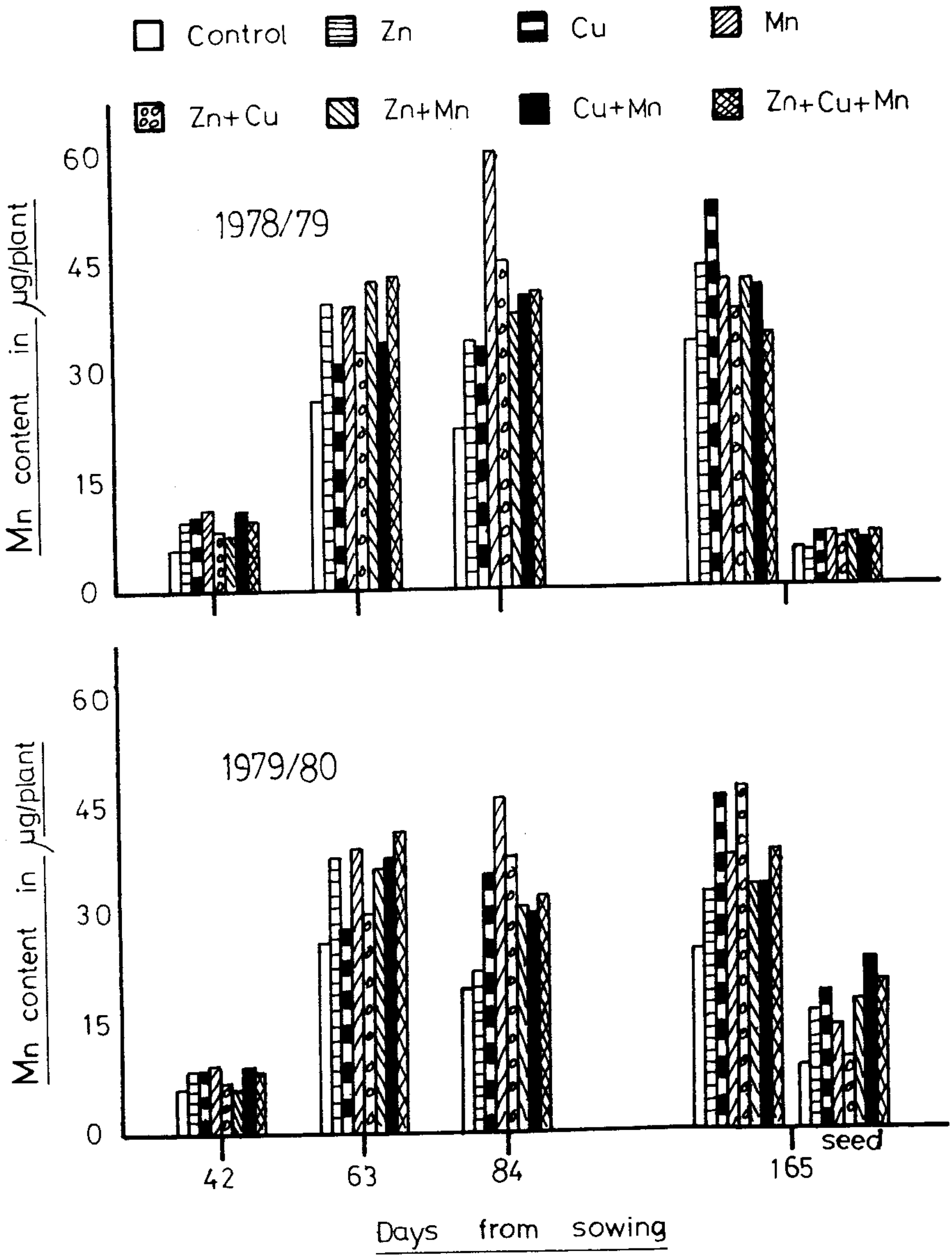

Fig.(14)- Effect of micro-nutrients on manganese content (in µg/plant) at different stages of growth in 1978/79 and 1979/80 seasons.