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# Mn ASSIMILATION BY SUNFLOWER DURING ONTOGENESIS AT DIFFERENT LEVELS OF MACROELEMENT SUPPLY

By

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## Summary

An investigation on the assimilation of Mn from the soil by sunflower during ontogenesis has been carried out on a slightly leached chernozem, with a systematic application of increasing $P_2O_5$ doses at 2 levels of NK-fertilization.

The most important conclusion of the experiment are as follows: In the conditions of the slightly leached chernozem of Dobrudja, sunflower plant assimilates Mn with high intensity from its earlier age till the end of flowering phase. Assimilation of Mn after this phase decreases sharply, till about the end of filling in of the seed phase the plant loses a part of the Mn already assimilated.

The basic quantity (44-78%) of Mn, necessary to form the yield, sunflower plants uptake during the flowering phase. Concentrations of Mn in the leaves are highest during the same phase.

Mn, assimilated by the plant (46-82%, depending of the development phase) is accumulated in the leaves and does not undergo any redistribution during generative phase.

The lasting systematic fertilization with N and K fertilizers, as well as their combination with P fertilizer, increase the entry of Mn in sunlfower. P fertilization in the period of vegetative growth depresses the intensity of Mn - entry in the top growth. NK fertilization increases the concentration of MN in all organs. P fertilization increases the same concentrations only in the leaf blade.

## Introduction

Although the important physiological function of Mn in theprocesses of photosynthesis are well known, Mn assimilation by the sunflower plant during ontogenesis is still not well studied. Insufficient information exists on the mobility and the distribution of the assimilated Mn in the organs, depending on the level of macroelement supply. The effect of macrofertilizers on the mobility and the entry of Mn in the plants may be, sometimes, of significant economic importance. For example, in some soils of North Bulgaria one can observe a Mn-toxicity in sunflower, that is due to intensive fertilization with ammonium nitrate (2).

The present investigation is aimed at manifesting the uptake, the distribution by organs and the quantity of Mn taken out from the soil by sunflower plants during the more important phases of ontogenetic development and the effect of systematical application of mineral fertilization on the same processes.

## Material and Method

Investigation was carried out on a lasting field experiment, started in 1963 on a slightly leached chernozem in Dobrudja. Sunflower variety Peredovik was grown in a crop-rotation pair, after wheat.

Investigated variants of macroelement fertilization: 1. Non-fertilized; 2. Fertilized with superphosphate in doses of 0, 40, 80, 160 kg/ha of $P_2O_5$ on a background of 120 kg/ha of N as $NH_4NO_3$ and 80 kg/ha of $K_2O$ as KCL; 3. Fertilized with superphosphate in doses of 0, 80, 160 and 320 kg/ha of $P_2O_5$ on a background of 180 kg/ha, of N as $NH_4NO_3$ and 120 kg/ha of $K_2O$ as KCL. Samples for a chemical analysis were taken in 1973 and 1975, as average samples of the four replications of each variant were made.

Dates of collecting samples correspond to six phases of plants development: I phase -- 3-4 pairs of leaves; II phase -- 8-10 pairs of leaves; III phase -- bud formation period; IV phase -- flowering; VIphase -- full seed maturity; V phase -- filling in of grain. Plants were separated by leaves, petioles, stems, heads, and seeds as their air-dried weight was then measured. MN content was fixed by an atomic absorbtion spectrophotometer, Sp-90, in a salty-acid extract after a dry combustion.

At the end of the vegetation seasons of the 2 years of investigation, soil samples were tested to determine the more important agrochemical characters (Table 4).

## Results

### 1. Concentration of Mn in the tissues.

Significant differences of Mn concentrations in the separate plant organs and in the different development phases were established (Figure 1). Highest concentrations were found in the leaf blade, varying between 125-260 ppm, in accordance with the plants age and the different variants of fertilization. Then, in a descending line follow the stems (15-220 ppm), petioles (60-180 ppm), heads (15-98 ppm), and seeds (15-20 ppm).

Changes in the concentrations of different phases are not one-way for the separate organs. In the first phase, highest concentrations are established in the stems, followed by the leaves and the petioles. In second phase concentrations in all organ decrease significantly, as the decrease is sharpest in the stems. Concentration in the leaves and leaf stems manifest one-way changes during vegetation period. During flowering phase concentrations of Mn in these organs increase significantly and exceed the values established in Phase 1. The same peak in the concentrations of Mn in flowering phase is observed in the buds, too. A certain slight increase of concentrations in the stems during the same phase is established only in a part of the tested variants.

Fertilization with macroelements exerts a perceptible and unequal effect on Mn-concentrations in the different sunflower organs. Most considerably vary, under the influence of macrofertilizers, the concentrations in the leaves and the petioles. Higher concentrations of Mn, if compared with the non-fertilized variant and variants with P, are established in variants of NK-fertilization without P; in the stems during first phase, in the heads during fourth phase, and in the leaf and stems during the whole vegetation period. The growing levels of P-fertilization decrease the concentration of Mn in phloem fibers, throughout all phases, while in the leaves, on a low NK background, the decrease takes place only in second and third phases. During flowering phase P-fertilization increases Mn-concentration in the leaves irrespective of the NK-level.

## 2. Intensity and dynamics of Mn assimilation during the ontogenesis.

According to data in Figure 2 for all variants the intensity of Mn-assimilation during the ontogenetic development of plants represents a dropping curve line with 2 maximums -- the first one in the earliest age of the plant and the second one -- that can be, in some of the variants lower than the first, during flowering period. In the phase of filling the seed, the intensity of Mn-assimilation strongly decreases. Mn assimilated for 24 hours in 1g dry matter comes to 3-4 times less than the same, during flowering phase. In the period of vegetative growth the intensity of Mn-entry is higher in variants of non-phosphorus fertilization and in variants of low doses of P. However, increasing levels of P-fertilization during flowering phase increase the intenstiy of Mn-assimilation. Table 1 shows the dynamics of Mn-uptake, while Table 2 represents the accumulation of dry matter from one plant by the separate phases of development. It can be seen that in the first phases sunflower assimilates comparatively small quantities of Mn. About 15-20% out of the total quantities for the whole vegetation period are assimilated in the bud-formation period. The main part of Mn about 44-78%, necessary for the yield formation, are assimilated by sunflower during flowering phase. During the phase of filling in the seeds the uptake of Mn sharply decreases no matter that the accumulation of dry matter is still intensive, while in ripening phase the plant loses some of the assimilated Mn.

At a high NK-background in variants $P_{160}$ and $P_{320}$, losses appear as early as the phase of filling in the seeds.

The level of macroelement supply exerts a significant influence on the assimilation of Mn by sunflower in the different phases. Up to flowering phase inclusive, the quantities of assimilated Mn are positively interrelated to the level of P-fertilization. The positive effect of P supply is better expressed at a high NK-background. In phase filling in of seeds, the positive interrelation between P supply and the assimilation of Mn by the plants is preserved only at a low NK-background. An inverse tendency is observed with a high NK-background.

## 3. Distribution of Mn in the different sunflower organs.

During the entire period of growth and development and in all investigated variants, the main part (46-81%) of Mn is distributed in the leaves (Figure 3). About 8.7-28% are found in the stems according to the plant's age and the level of macroelement supply, about 2-12% in the leaf stems, 0.2-18% in the heads and

Table 1: Dynamics of Mn-uptake from one plant in mg and in % of the quantity assimilated during the whole growing period.

| Азотно калиев фон kg/ha | $P_2O_5$ kg/ha | Phases: 2.5–29.5 I | | 29.5–11.6 II | | 11.6–22.6 III | | 22.6–9.7 IV | | 9.7–15.8 V | | 15.8–11.9. VI | | 2.5–15.8. /Total/ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | мг | % | мг | % | мг | % | мг | % | мг | % | мг | % | мг | % |
| $N_0K_0$ | 0 | 0,15 | 1,89 | 0,55 | 6,93 | 0,90 | 11,33 | 3,42 | 43,07 | 2,92 | 36,77 | -1,39 ** | 17,5 | 7,94 | 100 |
| $N_{120}K_{80}$ | 0 | 0,08 | 0,77 | 0,50 | 4,83 | 1,79 | 17,31 | 4,98 | 48,16 | 2,99 | 28,92 | -0,48 | 4,64 | 10,34 | 100 |
| | 4 | 0,16 | 1,05 | 1,04 | 6,84 | 2,51 | 16,52 | 7,18 | 47,26 | 4,30 | 28,30 | -2,65 | 17,44 | 15,19 | 100 |
| | 8 | 0,23 | 1,38 | 0,81 | 4,88 | 2,10 | 12,67 | 10,13 | 61,13 | 3,30 | 19,92 | -1,43 | 8,63 | 16,57 | 100 |
| | 16 | 0,31 | 1,84 | 1,41 | 8,38 | 2,08 | 12,36 | 9,57 | 56,86 | 3,46 | 20,56 | -1,93 | 11,47 | 16,83 | 100 |
| $N_{180}K_{120}$ | 0 | 0,14 | 1,05 | 0,43 | 3,23 | 0,94 | 7,06 | 6,34 | 47,66 | 5,45 | 40,98 | -2,43 | 18,27 | 13,30 | 100 |
| | 8 | 0,15 | 0,95 | 1,09 | 6,90 | 1,49 | 9,44 | 9,09 | 57,60 | 3,96 | 25,09 | -2,23 | 14,13 | 15,78 | 100 |
| | 16 | 0,35 | 1,85 | 1,59 | 8,39 | 3,11 | 16,41 | 13,90 | 73,35 | -2,51 | 13,24 | -1,22 | 6,44 | 18,95 | 100 |
| | 32 | 0,37 | 2,27 | 1,36 | 8,34 | 2,14 | 13,12 | 12,44 | 76,27 | -1,41 | 8,64 | -1,02 | 6,25 | 16,31 | 100 |

** - loses

TABLE 2. Dynamics of dry-matter accumulation from 1 plant in g/24h.

| Background kg/ha | $P_2O_5$ kg/ha | From germination till 29.V | From 29.V til 11.VI | From 11.VI till 22.VI | From 22.VI till 9.VII | From 9.VII till 16.VII | Matur grain in g/plant |
|---|---|---|---|---|---|---|---|
| Non-fertilized | | 0.05 | 0.52 | 0.95 | 2.97 | 3.00 | 55.9 |
| $N_{120}K_{80}$ | 0 | 0.03 | 0.48 | 1.67 | 3.50 | 3.25 | 60.5 |
| | 40 | 0.06 | 0.79 | 2.17 | 5.19 | 4.43 | 77.7 |
| | 80 | 0.09 | 0.71 | 2.04 | 4.98 | 3.82 | 83.0 |
| | 160 | 0.10 | 1.36 | 2.43 | 5.10 | 4.70 | 83.0 |
| $N_{180}K_{120}$ | 0 | 0.03 | 0.34 | 0.78 | 3.11 | 3.89 | 68.2 |
| | 80 | 0.05 | 0.86 | 1.63 | 5.76 | 3.53 | 80.9 |
| | 160 | 0.12 | 1.28 | 3.16 | 6.25 | 3.71 | 81.8 |
| | 320 | 0.19 | 1.23 | 2.77 | 5.32 | 4.12 | 81.4 |

TABLE 3. Uptake of Mn with the harvest.

| N - K Background kg/ha | $P_2O_5$ kg/ha | Mn - Uptake in g | | Total |
|---|---|---|---|---|
| | | In 100 kg grain | In the whole vegetative mass of 100 kg of grain | |
| $N_0K_0$ | 0 | 1.699 | 8.285 | 11.72 |
| $N_{120}K_{80}$ | 0 | 1.603 | 15.543 | 16.27 |
| | 40 | 2.394 | 13.868 | 16.15 |
| | 80 | 2.494 | 14.856 | 18.20 |
| | 160 | 2.205 | 15.233 | 18.28 |
| $N_{180}K_{120}$ | 0 | 1.906 | 15.500 | 16.34 |
| | 80 | 2.311 | 20.171 | 22.48 |
| | 160 | 2.300 | 16.308 | 18.61 |
| | 320 | 2.395 | 15.991 | 17.10 |

Table 4

| Variants | | PH | Aveilible nutrients in the soil | | | |
|---|---|---|---|---|---|---|
| Backgroiund | $P_2O_5$ | /KCl/ | N mg/1000g | $P_2O_5$ | $K_2O$ | Mn mg/1000g |
| | | | | mg/100g | | EDTA |
| kg/ha | kg/ha | | /Cornefield/ | /Egner-Reem/ | | PH = 8,6 |
| Non-fertilized | | 5.78 | 28.0 | 2.0 | 30 | 6.4 |
| $N_{120}K_{80}$ | 0 | 5.50 | 41.3 | 1.2 | 29 | 6.2 |
| | 40 | 5.45 | 33.0 | 1.8 | 28 | 3.5 |
| | 80 | 5.40 | 36.4 | 5.3 | 27 | 5.8 |
| | 160 | 5.28 | 36.4 | 14.2 | 29 | 6.4 |
| $N_{180}K_{120}$ | 0 | 5.25 | 37.8 | 1.2 | 30 | 6.4 |
| | 80 | 5.20 | 37.1 | 4.2 | 27 | 3.5 |
| | 160 | 5.30 | 33.6 | 10.9 | 27 | 5.9 |
| | 320 | 5.15 | 33.6 | 29.0 | 30 | 6.4 |

Fig. 1: Mn-concentration: (a) in the leaves; (b) in the leaf stems;

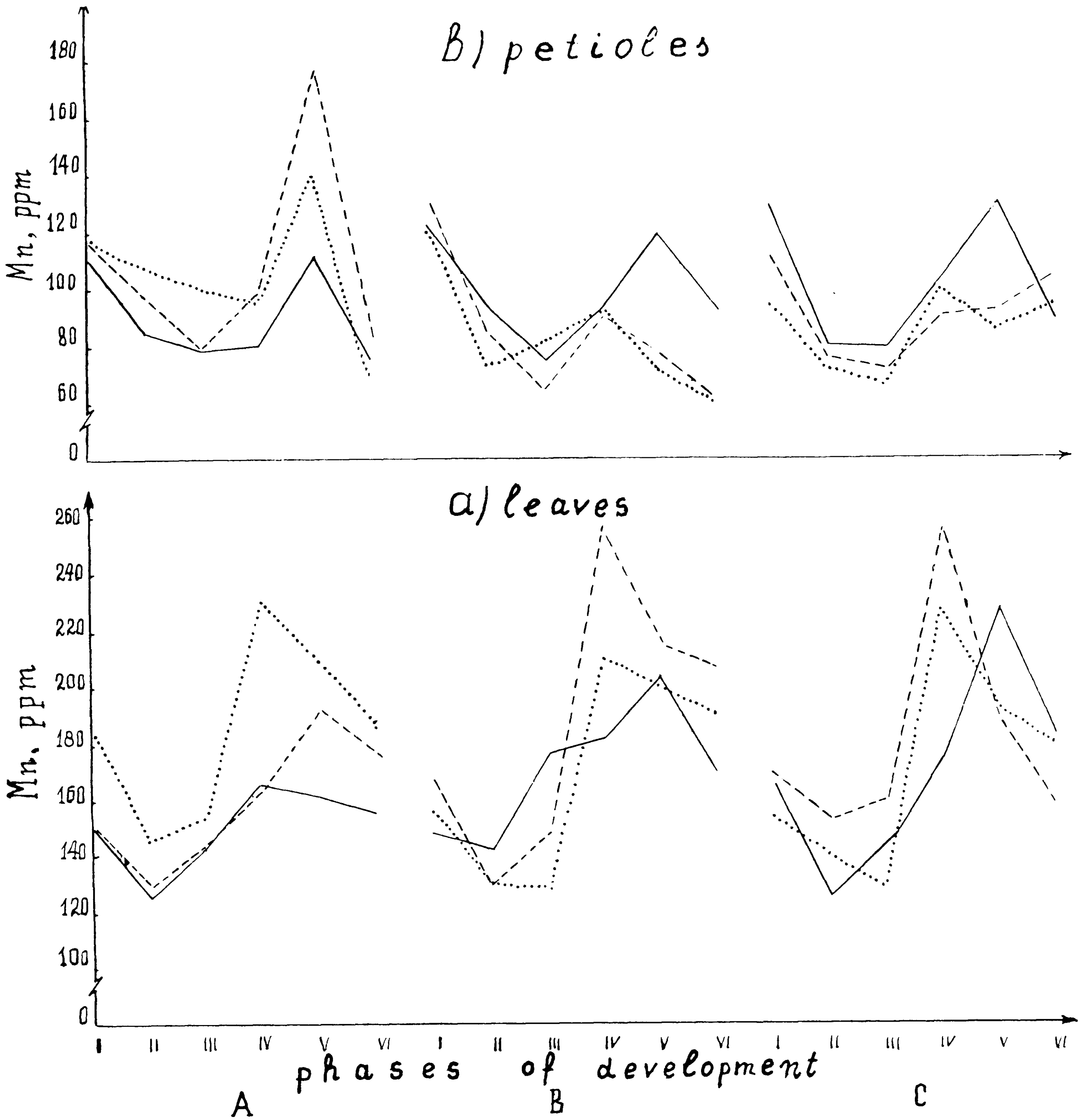


Fig. 1 (c) in the stems; (d) in the heads; (e) in the grains.

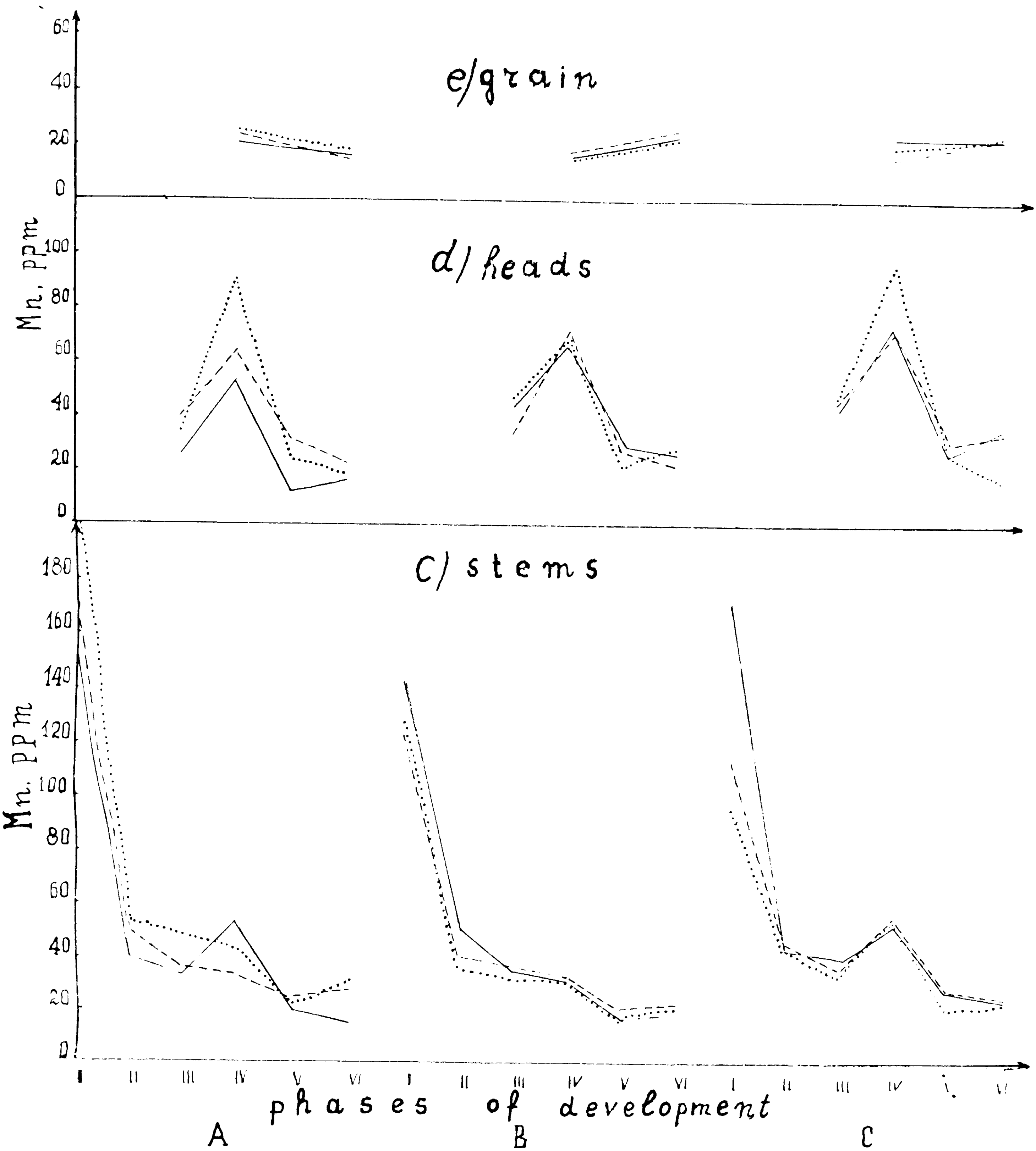
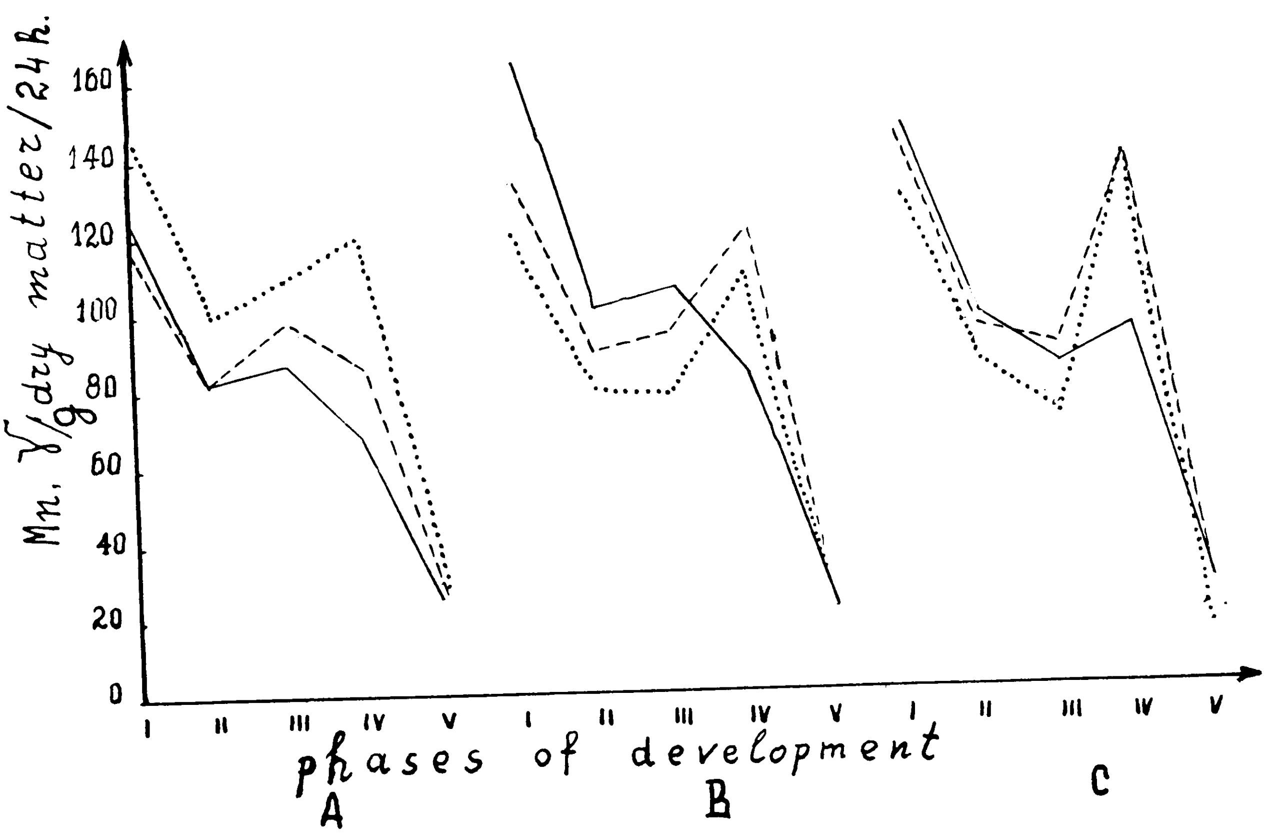


Fig. 2: Intesity of Mn-uptake in the tops of the sunflower in mcg/g dry matter for 24 hours.



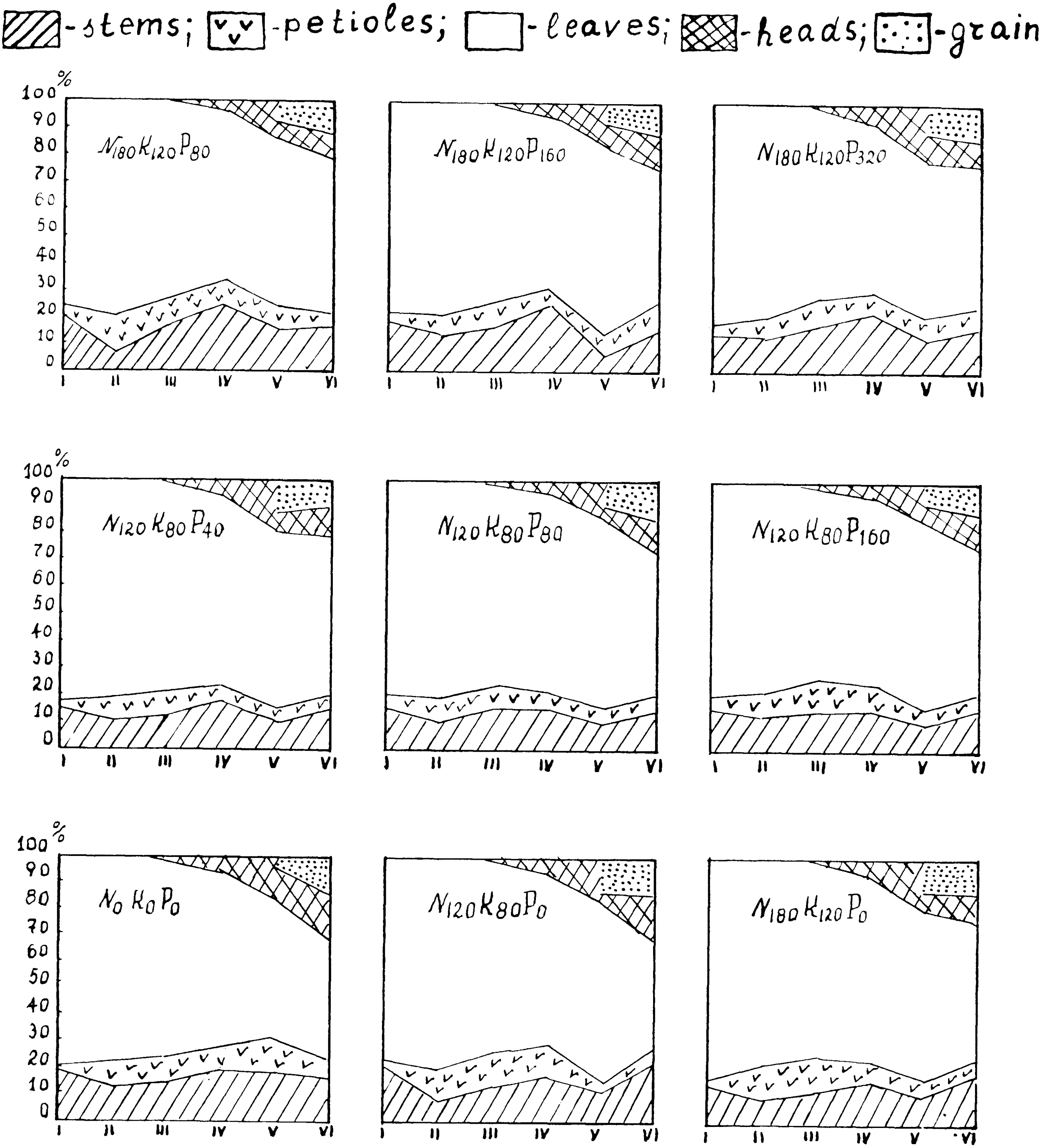



Fig. 3: Distribution of Mn in sunflower organs during the growing period in % from its total quantity in the plant.

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