THE EFFECT OF GROWTH ORGANIZATION OF CALLISTEPHUS CHIN. NEES.ON THE VEGETATIVE GROWTH DEVELOPMENT AND SEED PRO DUCTIVITY OF PLANTS

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Abstract

The usual growing distance of seed production of Callistephus is 400 x 200 to 300 mm depending on the heigh of the plants. We tested the effect of different densities, 400 x 100 to 300 mm, on relative rrowth rate R, productivity C, net asimilation rate NAR and seed yield. Plant efficiency increases due to higher density towards the end of vegetation period. Seed yields per plant are lower and absolute weight of seed yields per area always higher and absolute weight of seed lower. Germination rate of seeds does not differ.

1.Introduction

In seed crop stands considerable losses ocur during vegetaton amounting to as much as 25 % of the number of plants. This comes about through treatment,thinning,disease and so on. Thus, due to poor cover, the eventual output is below the expected target. With spacings of increased density - as much as doubled according to variety of China asters - it is possible to eliminate these losses and to dramatically increase the seed yield. Our experiment studied the behaviour of plants in dense stands as well as their growth and development patterns.

2. Material and methods

The experiments were started through direct sowing on the site in the period from 25.March till 8.April depending on the weather, in the years 1982 to 1985.
Our locality, Lednice na M., lies in Central Europe 48°48' North and 16°48' East with an altitude above sea level 172 m and average annual reinfall 416,6 mm /of which 324,4 mm comes in irregular distribution during vegetation seaseon/ due to the evident rain shadow of limestone massif nearby.
The soil is chernozem, sandy loam on loess, neutral to slightly alkaline, maize-barley production type.
The cultivars used were either low, bedding types:
'Sázava', 'Ohře', 'Álena', 'Pinokio',
or high, for cutting: 'Armida', 'Tamara', 'Edita', 'Irma'.
Spacing for indiviudal variants:
Row to row distance: 400 mm for all variants

Within the row, the low types were set 100,150 and 200mm
the high types 150, 200, 250, and 300 mm.
The were 3 parellel replicas of each experiment every year. Growth analysis was made according to the standart destruction method / Šesták, Čatský, 1966/. From each density /variant/ 3 pairs of plants were taken. One plant of each pair was analyzed, the other kept for further study.

Leaf area ´L ,and leaf area index ´LAI´ $\frac{A\ /m^2/}{P\ /m^2/}$

specific growth rate ´R´g. /g.time/$^{-1}$
biomass weicht´W´ in grams
net assimilation rate ´NAR´g.m^2.t^{-1}
productivity ´C´ g. m^2. t^{-1}

Seed yield was calculated from the yield of typical 10 plants in a continuous stand, averaged out for one plant, and converted to $\bar{x}$ a yield of 1 ha with continuos cover assumed. Germinating capacity was establisbed in laborat. conditions according to the relevant standart as the average from 4 x 100 and 4 x 1000 seeds for absolute weight. Phenologically, the following stages were recorded: emergence, formation of ground level rosette, elongation of stems, formation of flower buds, flower onset and full flower, end of flowering, formation of seeds and their maturation, seed harvest.

3. Results

3.1. Specific growth rate R could be expressed as twopeak curve in all cultivars. The first peak was situated in the stem elongation stage /exactly at transition from ground level rosette to budding/. After that, all variaties showed a drop in R. The second peak occured vhen the flower buds opened to full flower. A rapid decrease of R followed in all cultivars and all variants. In dense spacings the second peak was more pronounced and these plants outgrowed the plants in standart spacings. Higher cultivars competed more in denser spacings. Therefore, higher R was found here inearlier stages than it was the case for low varieties.

3.2. Leaf area A and leaf area index LAI depend most of all on stand density. High value of LAI resulted in a drop of productivity C in the stand and in a decrease of NAR, both due to competition. A high value of LAI is likely to occur not only in the highest density. Optimal LAI appeared to be around 3. Strikingly lower values, or, for that matter, higher values than 3 caused a decrease of productivity and output.

3.3. Net assimilation rate NAR in low cultivars corresponded in its dynamic pattern to R. The maximum of NAR in low China asters was found to occur during the stem elongation stage and from flower onset till full flower. Stands with higher density had the top Nar values higher. Nar behaved as a two peak curve with the first peak generally higher in thinner stands and the second one higher in denser stands. The NAR curve in higher cultivars resembled rather a one-peak curve with maximal values found in flower-onset-till-full-flower stage in all variants. At full flowering NAR values sink rapidly in both high and low cultivars, especially if the max. reachedbefore that was high. For a relatively flat NAR curve, the total value remains somewhat high for a longer period.

3.4. The productivity C - is strongly dependent on external influences, that is, among others temperature and raifall after the end of ground rosette stage. Depending on the weather, significant year to year differences could be observed in C. Low cultivars reached maximum C at the start of flowering - late in July,early in August. Stands with the highest density showed the highest C. After the full flowering of stands C drops rapidly. In standart and thinner spacings the C-curve was slightly more evened out. High cultivars showed a dramatic rise in productivity at the start of flowering, which was a behaviour similar to low cultivars. This rise coincided with the maximal NAR. Maximal C is sligtly retarded in stands with the highest density, onaverage 10 days later than a standard variant.

3.5. The seed output of individual plants did not depended simply on density. Both in dense stands and in standard ones there were yields from individual plants higher or lower on average by 30 %. Individual yield depended rather on climatic effects of different seasons. Under the conditions of our experiment the yields from standard variants were generally average and above average. Seed outputs from a unit of area were conspicuously dependent upon the density of stands. Dense stands gave decidedly higher yields for an area unit, the difference being as high as 200 %
The number of inflorescences per plant was in no direct relationship with seed yield. The latter depended on the size of inflorescences, on their repletion with seeds, nad last not least on the size and wight of seeds.
The germinating capacity of seeds established in all trials exceeded 70 %. Its variation was due to changing climate from year during the relevant periods of flowering of stands and maturing of seeds.
Overall stand health did not differ between variants, which was a result of normal prevention against pests and diseases.

4. Diskussion

Our experiments have shown the effect of stand density on the growth pattern of plants and on the formation of economic output in Callistephus chin. Nees.The most important stage of biomass formation was found to take

place just after setting of flower buds in both low and high cultivars. The onset of flowering till full flowering is the decisive period with the top productivity C of plants. It takes 20 days at the most.
It could be assumed that this period is vital nat only for biomass formation but also for production of seeds.
A typical feature is the simultaneitly and interaction of maximal values for C, R, and NAR growth functions. The maximal values were found to be more clearly massed within one relatively short period in the stands with the highest density. In cases where maximal values of C, R, and NAR occured at different times, a poorer seed yield could be observed.
Stand density affects also growth pattern and shaping of individual plants. In standart spacing the plants had a regular distribution of branches and leaves. Lateral growth was limited in densest stands, but the branching was good. High remounting cultivars kept on growing new infloreszences set flowers repeatedly. In dense stands there was a continuous strip of interlocked flowers in each row. The increased density of spacings was tolerated well by plants. Growing number of individuals on a given area corresponded to increasing growth functions.
Competition was quite rere and it resulted in a repid decrease of NAR. The cause was high covering capacity of the leaves, i.e. the competition between upper and lower leaf layers. This was based on an uneven distribution of rainfall water which lead to more intensivegrowth of late high cultivars during full flowering.
Fortunately, this circustance did not affect seed yield nor seed quality.

5. Conclusion

The objective of the present work was to study the growth and development of a seed crop stand in relation to its different densities with a wiev to economic output. Crops of low and high cultivars obtained through direct sowing were arranged in 400 x 100 to 300 mm spacings according to the growing capacities of different cultivars.
It was shown that
- the productivity C was vital importance for maximal biomass accumulation and formation of econimc output
- the optimal values of leaf area index is equl to 3
- the simultaneity of C, R, and NAR peaks in vital developmental phases is something to be desired if the yield formation is to be influenced positively in a complex and interactive way.

Based on these results, we recommend to grow seed stands of China aster with above-normal density reaching as many as 50 to 100 % individuals more per area unit. At these densities it is possible, with present agronomic measures, to ensure much better yields of good-quality seeds.

References

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By way of demonstration, the results of the year 1984, vhich was from the seed-grower's point of view, are given for 2 cultivars in tables and graphs.

Cultivar ´Tamara´, 1984 /high, needle for cutting/

interval	date	pheno phase	density in mm 400 x 150			
			R	NAR	C	LAI
1	21. 6.	1	0. 070	4. 638	-	-
2	3. 7.	2	0. 060	2. 691	6. 801	1. 650
3	13. 7.	3	0. 039	2. 701	7. 305	3. 700
4	24. 7.	4	0. 029	3. 135	7. 513	1. 975
5	31. 7.	5	0. 131	19.899	56.711	2. 950
6	6. 8.	6	0. 016	4. 140	11.217	2. 775
7	16. 8.	6	0. 011	3. 106	8. 504	2. 700
8	24. 8.	6	0. 009	2. 840	7. 606	2. 800
9	3. 9.	6	0. 006	2. 174	5. 908	2. 600
10	13. 9.	7	-	-	-	2. 925
			400 x 200			
1	21. 6.	1	0. 055	1. 349	-	-
2		2	0. 079	3. 073	6. 112	1. 012
3		3	0. 025	1. 104	3. 209	3. 581
4		4	0. 039	2. 897	6. 703	2. 456
5		5	0. 082	9. 986	21.012	2. 231
6		6	0. 040	8. 566	16.308	1. 987
7		6	0. 027	3. 998	15.111	1. 837
8		6	0. 015	4. 320	10.313	2. 775
9		6	0. 008	2. 966	6. 504	2. 062
10	13. 9.	7	-	-	-	2. 325
			400 x 300			
1	21. 6.	1	0. 011	0. 496	-	-
2		2	0. 125	3. 252	4. 904	0. 825
3		3	0. 041	1. 737	3. 611	2. 575
4		4	0. 079	7. 371	11.707	1. 675
5		5	0. 064	9. 846	15.013	1. 525
6		6	0. 032	7. 634	10.709	1. 550
7		6	0. 012	1. 345	4. 910	1. 275
8.		6	0. 004	1. 314	1. 912	1. 687
9		6	0. 003	1. 118	1. 408	1. 250
10	13. 9.	7	-	-	-	1. 437

Cultivar ´Alena´, 1984 / low, bedding type /

interval date		pheno phase	density in mm 400 x 100			
			R	NAR	C	LAI
1	11. 6.	1	0. 031	2. 209	-	-
2	21. 6.	2	0. 024	1. 704	2. 901	1. 462
3	3. 7.	3	0. 064	6. 817	12.503	1. 987
4	13. 7.	4	0. 036	5. 327	11.811	1. 687
5	21. 7.	5	0. 042	6. 210	19.207	2. 851
6	31. 7.	6	0. 087	13.618	36.204	3. 375
7	10. 8.	6	0. 017	3. 345	16.513	5. 709
8	21. 8.	6	0. 012	2. 044	13.402	4. 237
9	3. 9.	7	0. 009	1. 257	11.014	9. 637
10	13. 9.	8	-	-	-	7. 912
			400 x 150			
1	11. 6.	1	0. 034	2. 774	-	-
2	21. 6.	2	0. 029	2. 213	2. 703	1. 002
3	3. 7.	3	0. 049	4. 516	7. 315	1. 551
4		4	0. 038	5. 469	9. 016	1. 707
5		5	0. 033	5. 541	10.921	1. 625
6		6	0. 063	10.137	28.222	2. 375
7		6	0. 036	7. 668	23.512	3. 212
8		6	0. 012	2. 334	10.341	2. 975
9		7	0. 009	1. 369	8. 303	6. 375
10		8	-	-	-	5. 813
			400 x 200			
1		1	0. 036	2. 890	-	-
2		2	0. 030	2. 629	2. 011	0. 693
3		3	0. 080	8. 286	10.103	0. 913
4		4	0. 055	9. 954	14.212	1. 612
5		5	0. 040	10.063	15.705	1. 256
6		6	0. 025	5. 362	12.204	1. 912
7		6	0. 012	2. 465	7. 314	2. 756
8		6	0. 010	1. 808	6. 718	2. 718
9		7	0. 006	0. 912	4. 108	4. 875
10		8	0. 000	-	-	4. 181

Phenophase:
- 1 ground level rosette
- 2-3 main and side stalks
- 4 budding
- 5 onset of flowering
- 6 full flowering
- 7 final stage of flowering
- 8 maturation

Figure 1 - Mean yield per plant

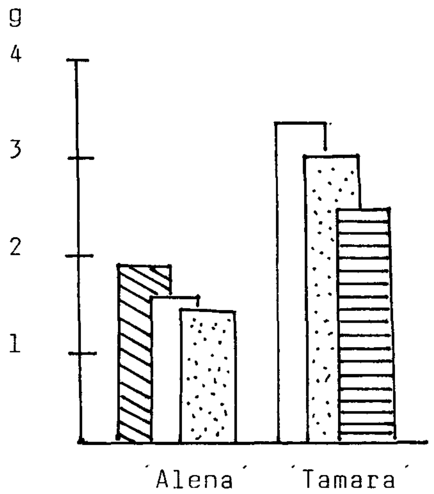


Figure 2 - Seed yield per 1 ha of continuous cover

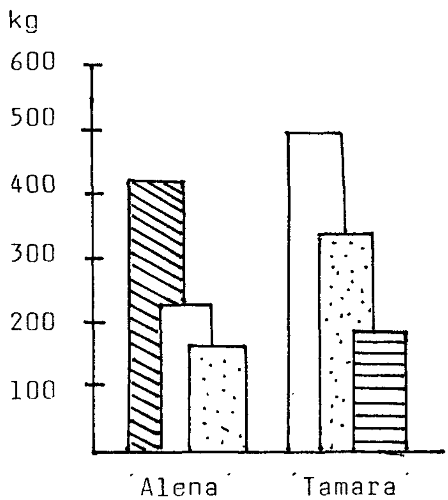
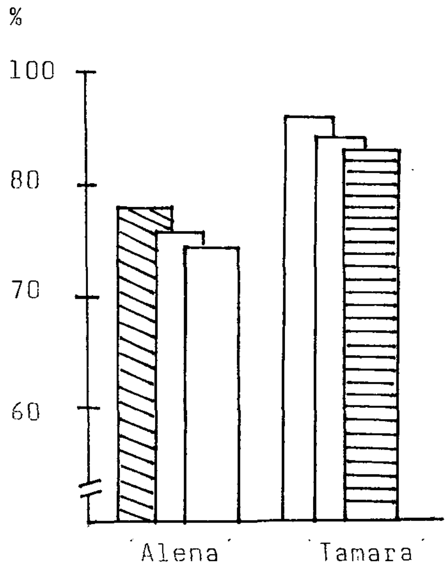


Figure 3 - Average germinating capacity



Captions

400 x 100 mm

400 X 150 mm

400 x 200 mm

400 x 300 mm