SUMMARY

The present work deals with some aspects of plant - environment complex in Linum usitatissimum L. - Linseed varieties: Early flowering Bengal 514 (P_1), and late flowering New Pusa 121 (P_2), and their hybrids. The object of these investigations was: (1) To determine correlations between development on the one hand and different components of growth, mineral metabolism and characters determining the yield of linseed varieties, on the other; (2) To study the energy requirement of these varieties; and (3) To study the behaviour of the hybrid population of a cross between the two varieties and its reciprocal under different photoperiods.

A historical account of work done so far on the influence of photoperiodic and vernalization treatments on the development of plants is presented. The interacting effect of light and temperature has been reviewed from the point of view of the photothermic requirement of plants belonging to different species. Further the influence of development on growth and morphogenesis has also been reviewed at length; and finally the literature on the modern concepts of the gene and gene action has been critically examined.

The actual experimental work was divided into two parts: (I) The effect of photoperiodic and vernalization treatment upon growth, development, mineral metabolism and yield of two varieties of linseed, named above; and (II) The effect of different photoperiods on growth, development and yield of two parents as well as F_1 and F_2 hybrids of linseed in relation to their photothermic requirement.

Unvernalized and vernalized plants were grown in earthen-ware containers with optimum nutritional level of the soil as well as with adequate watering under three photoperiods, short day (SD) of 8 hours, normal day (ND) of 11 hours, and long day (LD) of 19 hours (11 hours of natural + 8 hours of artificial) of illumination. Periodic measurements of height were made and simultaneously number of branches and leaves were determined. Sampling of plants was undertaken at fortnightly intervals to determine fresh and dry weights as well as water content of different parts of the plant. Relative growth rates were calculated according to Blackman's Compound Interest Law formula and net assimilation rate was determined according to Gregory's formula. Periodic samples of plant parts were analyzed for percent N, P and K contents and from that total N, P and K contents of

the whole plant as well as the absolute rates of uptake of these nutrients were also determined in accordance with Gregory's methods. From the total carbon content and different mineral contents C/N, C/P and C/K ratios were calculated. Further the partitioning of N, P and K in stem and leaf was also determined. Time of flowering (opening of first flower) and ripening of grain (flint ripe stage) were also determined and the growth period as well as the ripening period were calculated. From the meteorological data of maximum and minimum temperatures as well as hours of sunlight photothermic quanta for the homozygous parents and F_1 and F_2 hybrids were calculated out. Harvest data including grain yield and eight other characters determining yield were also collected.

In the case of hybrid populations, besides studying the dynamics of stem elongation as well as branch and leaf production throughout the growth period of the plant, seven other characters, viz., growth period, total dry weight, number of fruits, dry weight of fruits, number of seed, dry weight of seed and photothermic quanta were also studied in the two parents as well as in their F_1 and F_2 hybrids under normal day (ND) and long day (LD).

Statistical analysis including analysis of variance, determination of correlation coefficients and regressions of various data was carried out. The following are the salient features of the results presented in this thesis:

1. Long day treatment accelerates stem growth, whereas short day treatment tends to retard it. Vernalization treatment also brings about acceleration in stem elongation. The accelerating influence of long day and vernalization treatment on stem growth is clearly seen in the case of homozygous varieties of linseed. Similarly stem elongation is accelerated in heterozygous segregating F_2 population of the cross and its reciprocal. Relative growth rates for height are higher for LD plants in the earlier part of the growth period. Early variety Bengal 514 also shows faster rate of stem elongation during the earlier part of the growth period.

2. LD treatment appreciably reduces branch and leaf production in both the varieties as well as in hybrids. On the other hand SD treatment (which was given only in part I to the two linseed varieties) enhances branch production. Branch production increases progressively with the lateness in flowering of a variety or a hybrid plant. Low temperature treatment also tends to retard branch production in parents.

3. Periodic fresh and dry weights of both the parents and total dry weights of hybrids (both F_1 and F_2) are considerably reduced under long day treatment compared to those under normal day one. Vernalization treatment tends to decrease the final fresh and dry weights of linseed varieties. Rates of dry matter production in the plant as a whole and also in leaves and stem are accelerated by LD treatment.

4. Linseed varieties under LD and ND treatments show rapid decline in water content of different plant parts compared to SD ones. Water content of the late flowering variety remains at a higher level for a longer period of time and the decline is more gradual compared to that in the early variety.

5. Net assimilation rates for the fortnightly period between the two sampling dates is more or less the same in the case of ND and LD plants of both the varieties. On the other hand the value of net assimilation rate per hour of illumination is lower under LD treatment compared to the corresponding values under ND and SD treatments, presumably on account of the lower intensity of artificial illumination used for part of the long day treatment.

6. Total nitrogen, phosphorus and potassium contents of both the varieties follow more or less the same trend as dry matter production. LD reduces the mineral content while SD treatment increases it compared to that in the ND plants. Absolute rates of uptake of the above mentioned three mineral constituents show the earliest maxima in LD plants of both the varieties. Varietal effects are also quite clear; the early variety shows earlier maxima under all the three photoperiods. Even the accelerating effect of vernalization treatment is discernible on rates of mineral uptake. The partitioning of mineral nutrients also appear to be correlated with the rate of development of a plant. Thus the ratios of N, P and K contents of stem/leaf reach higher values earlier in LD plants followed by ND and SD ones. Early variety shows an earlier rise in the ratio under all the light treatments as well as in vernalized plants. The C/N, C/P and C/K ratios also register earlier maxima on the whole for LD plants followed by ND and SD ones. There is an earlier rise in these ratios of the early flowering variety. It, therefore, appears that the distribution of mineral nutrients in various parts of the plant is dependent upon the internal water balance of a plant which is governed by the time of flowering of a plant.

7. Photothermic quanta of the late variety as well as the late flowering F_2 hybrid plants of the cross as well as those of its reciprocal are of a higher order of magnitude compared to those of the early flowering variety as well as those of early flowering F_2 segregates. Values for F_1 plants are intermediate. The point worthy of note is that although LD treatment brings about considerable acceleration in time of flowering of a variety or in that of an F_2 hybrid plant the photothermic quantum remains constant for the variety or the hybrid under both the photoperiods. This is a very significant fact. Every growth character or flowering time or yield character of F_2 hybrid population studied shows a markedly different range of variation when grown under LD and ND conditions. Only the photothermic quantum, which can be considered as a measure of the energy trapping and conversion mechanism of a homozygous parent or a heterozygous F_2 segregate, does not alter beyond the range of experimental error.

8. In the case of harvest data also the influence of time of flowering can be seen. Lateness enhances the total dry weight of N.P. 121 as well as that of late flowering segregates. Under LD treatment both of them show reduced total dry weight. Number of fruits, weight

of fruits, number of grains and weight of grain all show the same tendency of being at higher levels in the case of the late flowering variety as well as late F_2 hybrid plants. This clearly indicates that the pattern of growth as well as the production of grain and other characters are correlated with the developmental process of linseed homozygotes or that of their F_2 segregates. This is borne out by studying the regression of growth characters on the rate of development. Such an analysis has been carried out both for characters of the two varieties of linseed as well as for F_2 segregating populations and highly significant linear relationships between a given character and the rate of development have been obtained. There is also a highly significant positive linear relationship between the growth period and the photothermic quantum of F_2 segregates.

9. Physiogenetical considerations arising out of the above mentioned work have been discussed in this thesis in the light of modern work in the subject. An independent genic analysis of each character without taking into consideration their correlations leads to the inevitable conclusion that the inheritence of each quantitative character is polygenic in nature. On the other hand if all the correlations mentioned in the work are taken into

account one will have to postulate pleiotropy of flowering genes. Still, however, considering the fact that genes for the developmental process are themselves polygenic; while the only unalterable entity in the plant is its energy trapping conversion mechanism as represented by its photothermic quantum a need for a physiogenetical postulation on the basis of energy relations of the plant becomes necessary. Such a concept has been discussed in this thesis, in which the potential of heredity - the Heredity Quantum is postulated to be composed of (i) a Structural Complex - Nucleon; (ii) an Energy Receptor Complex Energon; and (iii) a Development Complex - Metabolon.

On the energy trapping conversion ability of energon and the capacity of metabolon for converting this energy for powering the metabolic machine with the active participation of a given nucleon will depend the efficiency and output of the metabolic machine of the plant resulting finally into its growth and developmental pattern. The mass of data on growth, development, mineral metabolism and yield of two varieties of linseed and their F_1 and F_2 hybrids lends support to the above mentioned concept.