Journal of the Minnesota Academy of Science

Volume 22 | Number 1 Article 5

5-1954

A Comparison of Rate of Leaf Initiation in Seedlings of Zea Mays L. Under Field and Growth Chamber Conditions

A. Vincent Weber
University of Minnesota

Otto L. Stein
University of Minnesota

LITERATURE CITED

HORN, G., 1872. Descriptions of some new North American Coleoptera. Trans. Amer. Ent. Soc., 4:145.

RILEY, C. V., 1889. Systematic relations of *Platypsyllus* as determined by the larva. Insect Life, Wash., 1:300-307.

RUSCHKAMP, F., 1914. Zur Biologie der Leptinidae. Ins. Coleopt. *Leptinus testaceus* Mull. der "Mausefloh." Tijd. Ent., 164-174.

PARKS, J. & BARNES, J. (In press) Notes on the family Leptinidae including a new record of *Leptinillus validus* (Horn) in North America. Ann. Ent. Soc. Amer.

A COMPARISON OF RATE OF LEAF INITIATION IN SEEDLINGS OF ZEA MAYS L. UNDER FIELD AND GROWTH CHAMBER CONDITIONS

A. VINCENT WEBER AND OTTO L. STEIN

University of Minnesota, Minneapolis

This study on seedling growth of *Zea mays* L. is concerned with the rate of leaf initiation under experimental conditions as compared with field conditions. It was conducted in order to determine the experimental conditions necessary for the production of plant growth similar to that under field conditions. Three different environmental variables under artificial conditions were introduced. The criteria used for evaluation of the results obtained were, (1) the number of leaves produced during the seedling ontogeny of the shoot apex, and (2) the duration of the corresponding plastochrons. In addition limited observations were made on internode elongation.

MATERIALS AND METHODS

Four experimental runs of seedlings were conducted. Experiment 1 was grown under fluorescent lights, experiment 2 under incandescent lights, experiment 3 under incandescent lights with the addition of a nutrient solution and experiment 4, the control, under 1954 field conditions.

The seed used was the F_1 hybrid from the cross of Minnesota Station inbreds A188 x A25 . The first three runs were conducted in a constant temperature chamber, and except as noted, treatment of these was identical. The seed was surface sterilized in a 0.1% solution of mercuric chloride, soaked in water for 12 hours, then planted in washed sand in metal flats in the constant temperature chamber at $26\pm2°$ C. Planting distance was 4.5 x 4.5 cm. The fluorescent lighting apparatus consisted of a bank of twelve 40 watt tubes suspended 76 cm. above the

FIG. 1

RATE OF LEAF INITIATION

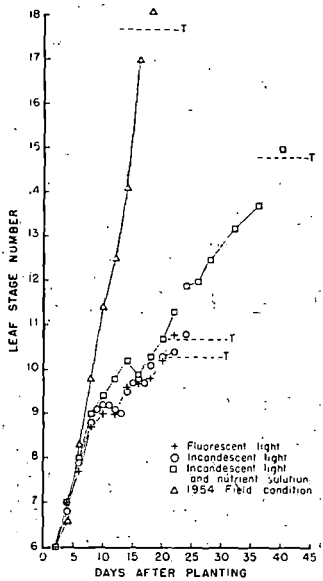


FIG. 2

RELATION OF RATE OF LEAF INITIATION UNDER INCANDESCENT LIGHT TO THAT OF INCANDESCENT LIGHT AND NUTRIENT SOLUTION

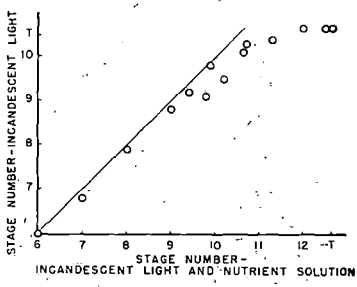


FIG. 3

RELATION OF RATE OF LEAF INITIATION UNDER INCANDESCENT LIGHT AND NUTRIENT SOLUTION TO THAT OF 1954 FIELD CONDITIONS

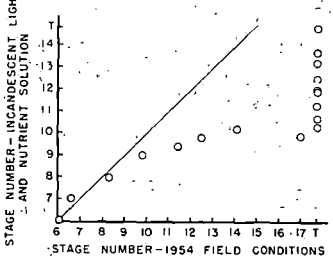


FIG. 5

AVERAGE INTERNODE LENGTH AS RELATED TO DAYS AFTER PLANTING

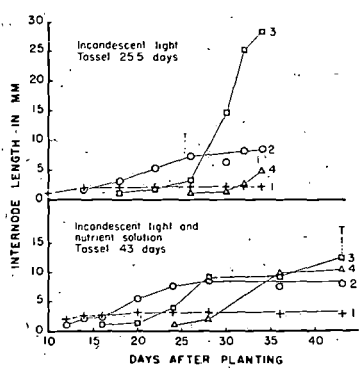
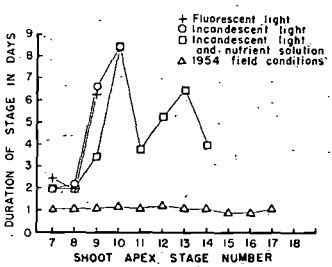


FIG. 4

DURATION OF PLASTOCHRON



sand level. The incandescent lighting apparatus consisted of nineteen 100 watt bulbs suspended 150 cm. above the sand level. Illumination of 14 hours concurrent with daylight hours was used in all runs. The planting beds were watered daily. Nutrient solution was added on alternate days. It consisted of a commercial product, 'Hyponex,' which was used in a dilution of 16 grams to 2 liters of water.

Samples were usually taken at two-day intervals. Immediately after harvest the plants were placed in a solution of FAA (Johansen, 1940). The shoot apices were then dissected out and the leaf stage recorded. From these determinations the average stage per day was calculated (Stein and Weber, 1954).

The control run was planted June 7, 1954 in the experimental plots of the Institute of Agriculture of the University of Minnesota, St. Paul. Samples were taken at two-day intervals and the plants dissected in the fresh state. Final total leaf count was taken at maturity. Other treaments were in accord with the methods described above.

The first seven samples in experiment 3 consists of 5 plants each. The remaining samples in all runs, with minor exceptions, are composed of 10 plants each.

The following method was used for determining final leaf stage and the time of tassel initiation. The average leaf stage associated with the differentiation of the tassel is a calculated value. It was determined by taking the mean of several samples which were collected at a sufficiently late date so that the tassel primordium could be identified unequivocally. This is a necessary precaution because of the difficulty of distinguishing between leaf primordia and tassel organ primordia in the very early stages of tassel formation. The calculated value for the average number of leaves produced by the plants before tassel formation is indicated by the broken line in Figure 1.

This method also permits an approximation of the average time of tassel formation even though the tassel primordia cannot be positively identified as such. This is accomplished by extrapolating the growth curve until it intersects the average final leaf stage (Fig. 1). Hence, the intersection represents an approximation of the point in time on the growth curve at which the apical meristem changes from a vegetative meristem to a reproductive meristem.

OBSERVATIONS AND DISCUSSION

Data for the rates of leaf initiation under the four sets of conditions are presented graphically in Figure 1. It can be readily seen that there exists little difference between plants when fluorescent lights and incandscent lights are the only variables. Also, the total number of leaves produced before tassel formation is essentially the same. However, it is quite apparent that when the nutrient solution is added the plants maintain the initial rate of leaf production somewhat longer than the plants grown under incadescent lights only. In addition, the entire period of

growth is prolonged considerably, with the result that an average of 14.8 leaves is produced before tassel formation, 39.5 days after planting. This is in contrast to 10.7 leaves at about 23.5 days after planting in the incandescent run.

All embryos of a sample of seeds taken at the time of planting and analyzed as to stage number were in leaf stage 6. Thus, from the time of planting to tassel formation, the seedlings in the fluorescent and incandescent runs produced on the average only 4.5 leaves while the seedlings in the nutrient run produced an average of 8.8 leaves. This compares with 11.7 leaves produced by the field grown plants in 25 days after the time of planting.

Figure 2 is a regression of leaf stage in the incandescent run against leaf stage in the nutrient run. This more clearly illustrates the relationship between the two environmental conditions. The solid line on the graph is the regression line on which all points would fall, if all leaf stages in the two experiments were initiated at identical time intervals. However, all points fall below the line indicating that the plants grown in the nutrient culture need less time for completion of a leaf stage. Thus, new leaves are being produced at a more rapid rate in the nutrient run. It appears that the endosperm does not supply an adequate amount of mineral nutrient even during the earlier stages of growth.

The plants grown with the addition of a mineral nutrient are compared with the field grown control plants in the regression in Figure 3. It is evident that while the addition of a nutrient speeds up and prolongs the vegetative growth period considerably, it by no means approaches growth as obtained under 1954 field conditions.

The duration of each plastochron in days was determined graphically from the curves in Figure 1. These values are compared in Figure 4. All three runs made under chamber conditions present the same general trend. Successive plastochrons show a longer duration irrespective of the experimental conditions. The excessive duration of leaf stage 10 in the nutrient run may be due to the fact that ear node formation is associated with this stage. In the field grown plants all plastochrons are of approximately the same duration up to plastochron 14. The later ones are of shorter duration due to the accelerated rate of leaf production at that time.

Under chamber conditions the quality of light, whether incandescent or fluorescent, does not materially affect the rate of leaf initiation. The addition of a nutrient solution enhances growth considerably, but not to the extent that it exists under field conditions. Thus, it may be stated that while a mineral supplement is desirable under growth chamber conditions, still other factors limit the chamber grown plants as compared with those grown in the field. There is an indication that light intensity may be the major limiting factor, but no conclusive evidence is yet available.

Average internode length was also determined for the plants in the incandescent run and the nutrient run. The internode lengths as related to days after planting are shown in Figure 5. Elongation under both sets

of conditions begins at approximately the same time even though the time prior to tassel formation is longer in the nutrient run. These limited data seem to indicate that intercalary meristematic activity as represented by internode elongation is controlled by a different morphological regulator than apical meristematic activity as represented by leaf initiation and ultimately tassel formation.

There is also an indication that lack of nutrient solution in the incandescent run causes greater elongation in the lower internodes in contrast to those in the nutrient run. This is an expected trend as field conditions are more nearly approximated. Under field conditions the first 5 or 6 internodes do not elongate.

SUMMARY

Seedlings of *Zea mays* L. of similar genetic constitution were grown under controlled conditions in three different environments and compared to a field grown control culture. The effects of the three different environments on the plants were analyzed in terms of the number of leaves produced during the seedling ontogeny of the shoot apex and the duration of the corresponding plastochrons. Some data on internode elongation were also considered.

The quality of light, whether fluorescent or incandescent, under these experimental conditions does not differentially affect the rate of leaf initiation, or the total number of leaves produced by the plants. With the addition of a nutrient solution, growth is considerably enhanced with respect to rate of leaf initiation, total number of leaves produced by the plants and overall duration of growth. However, even with the addition of a mineral nutrient the chamber grown plants do not nearly produce growth rates comparable to those under field conditions. It is suggested that other factors, possibly light intensity, are limiting.

In the chamber-grown plants successive plastochrons seem to be of longer duration irrespective of the experimental conditions. In the field-grown plants the first 14 plastochrons are approximately equal in duration. The later ones are of shorter duration due to the accelerated rate of leaf initiation at this time.

There is also an indication that the factors which control internode elongation are independent of those which control tassel formation. In addition, lack of mineral nutrient appears to result in excessive elongation of the lower internodes.

Thus, it is indicated from this study that the addition of a mineral nutrient is of importance in the growth of seedlings under controlled conditions, if growth patterns nearly simulating those of field-grown plants are to be obtained.

LITERATURE CITED

JOHANSEN, D. A. 1940. Plant Microtechnique. McGraw-Hill Book Company, Inc. New York.

STEIN, O. L. AND A. V. WEBER. 1954. A comparison of two methods of analysis of rate of leaf initiation in *Zea mays* L. Science 120:574-575.