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STAGES OF DEVELOPMENT IN LENTIL

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SUMMARY

Uniform descriptions of developmental stages in crops improve communication among producers, researchers and others. This paper gives a uniform system for the description of the developmental stages of lentil that we believe is not only universally applicable to all growing environments (field or greenhouse) and to divergent cultivars, but also useful for single plants or communities of plants. Vegetative and reproductive development are described separately. Vegetative growth stages are described by counting nodes on the main stem and continuing the count up the basal primary branch to include the highest fully developed leaf. Reproductive stages R1 and R2 are based on flowering, R3 to R6 on pod and seed development, and R7 and R8 on maturation.

W. Erskine, F. J. Muehlbauer y R. W. Short: *Etapas de desarrollo en la lenteja.*

RESUMEN

Las descripciones uniformes de las etapas de desarrollo de los cultivos mejoran la comunicación entre productores, investigadores y otros. Este trabajo presenta un sistema uniforme para la descripción de las etapas de desarrollo de la lenteja que creemos ser no sólo de aplicación universal para todos los entornos de cultivo (campo o invernadero) y para cultivares divergentes, sino además de utilidad para las plantas individuales o para las comunidades vegetales. El desarrollo vegetativo y reproductor se describen por separado. Las etapas de crecimiento vegetativo se describen contando los nudos en el tallo principal y continuando por la rama primaria basal para incluir la hoja completamente desarrollada más alta. Las etapas reproductoras R1 y R2 se basan en la floración, las R3 a R6 en el desarrollo de la vaina y semillas, y las R7 y R8 en la maduración.

INTRODUCTION

The life cycle of the lentil (*Lens culinaris* Medik.) plant is continuous and starts with seed germination and ends with complete seed maturation. It is vital that a common terminology for the different stages of growth is used for unambiguous communication between growers, researchers and others. This will allow, for example, the precise timing of cultural practices such as herbicide application, and the documentation of the growth stage where damage took place as a result of vagaries of weather such as hail, wind, late frost or attack by insects or other pests.

The lentil is grown under widely differing ecological conditions from the tropical highlands of Ethiopia to the Canadian prairies. At a single location, the growth of the crop is strongly influenced by factors such as the date of sowing, weather and cultivar. This paper gives a uniform system for the description of the developmental stages of lentil.

Both temperature and photoperiod profoundly affect the timing of flower initiation in lentil (Summerfield *et al.*, 1985). The onset of reproductive growth limits but does not halt vegetative growth. In view of the diversity of environmental conditions encountered by the crop, it is necessary to uncouple the descriptions of vegetative and reproductive growth stages and to describe them independently.

METHOD

Vegetative growth stages

The lentil is a much-branched, softly pubescent, light green, annual herbaceous plant with a slender stem and branches (Saxena and Hawtin, 1981). The branching habit of lentil contrasts with the better developed main stem axis of other food legumes such as pea (*Pisum sativum* L.), common bean (*Phaseolus vulgaris* L.) and cowpea (*Vigna unguiculata* L. Walp.). Descriptions of vegetative growth stages of bean, pea and soyabean have focused on the development of the main stem (Fehr *et al.*, 1971; Lebaron, 1974; Fehr and Caviness, 1977; Meicenheimer and Muehlbauer, 1982) but in lentil it is necessary to use the primary branches instead. Collectively, the primary branches carry 52% of the pods, compared with an average of only 17% borne on the main stem (Erskine and Goodrich, 1990). The basal primary branch also carries an average of 17% of the total pod yield, but, of more importance in the measurement of reproductive growth stages, it carries the nodes that are most frequently occupied by pods. Both vegetative and reproductive growth measurements in lentil focus on the basal primary branch.

Determination of vegetative and reproductive growth stages relies on node identification. A node is that part of the stem from which the leaf develops and is marked by a leaf scar when the leaf drops off so that node counts are unaffected by leaf loss. Describing the vegetative growth stage in lentils is accomplished by counting the number of visible nodes on the main stem up to the node subtending the basal primary branch and then continuing the node count up the basal primary branch to include the highest fully developed leaf. The cotyledonary node is designated as 0. The first two leaves are simple, scale-like and largely fused with two lateral scale-like stipules (Plate 1). The following two or more leaves are bifoliate and subsequent leaves multifoliate. Young leaves have leaflets resembling cylinders (Plate 2). As development progresses the leaflets unroll and flatten. To determine when the leaf is fully developed, leaf development at the node immediately above is observed. In lentil, a leaf is considered fully developed (and the node counted) when the leaf at the node above has unrolled sufficiently that the two edges of each leaflet are not touching.

When there is more than one branch from the node subtending the basal

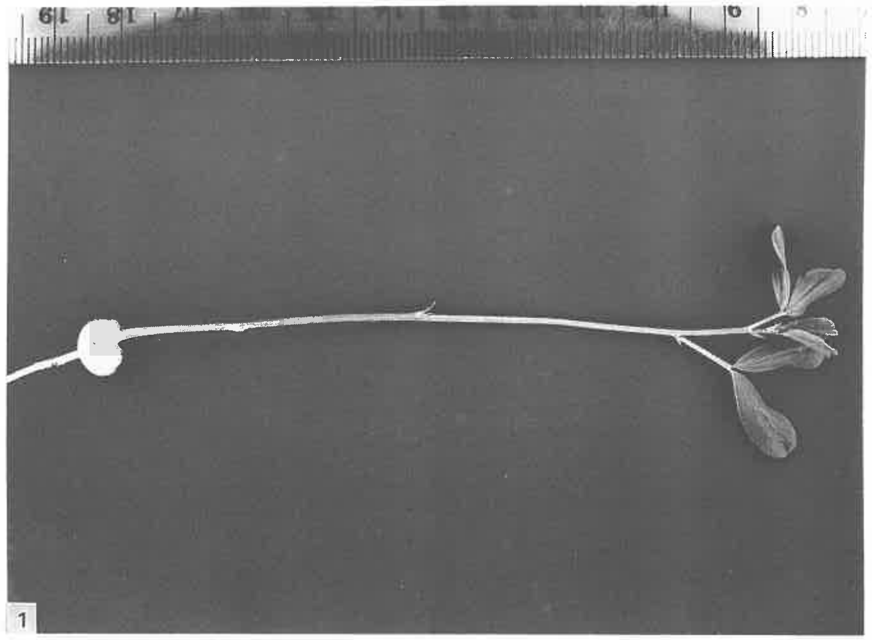

Plate 1. Lentil seedling showing the first two nodes with simple scale-like leaves and the third and fourth nodes subtending bifoliate leaves. The leaf at the fifth node has unrolled, so that the growth stage of the plant is V4 (magnification × 1.57).

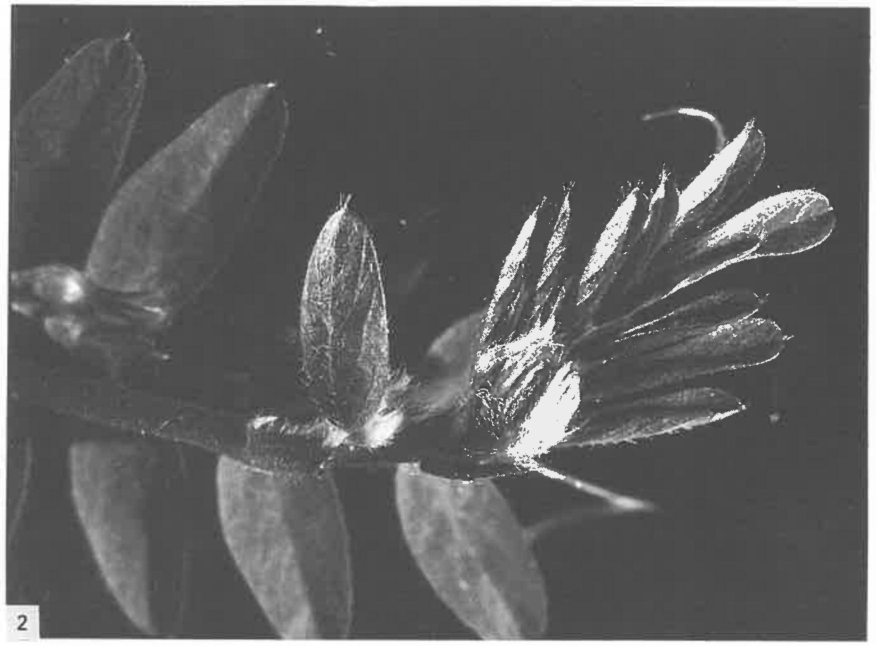

Plate 2. The leaflets on the young leaf are in various stages of unrolling (magnification × 7.2).

primary branch, the thickest of the branches can be used for the node count. The basal primary branch usually develops between nodes 1 to 5. Occasionally the basal primary branch either develops late at nodes above 5 or not at all; in these cases the main stem may be used for the node count. For example, a plant with four nodes is in vegetative stage V4 and a plant with 16 nodes in stage V16.

Reproductive growth stages

Flowering in lentil is indeterminate, occurring from axillary buds on the main stem and branches. It proceeds acropetally from lower to higher nodes. A single plant may have open flowers at high nodes and full pods in lower nodal positions at the same time. Many of the early flowers abort.

The choice of which part of the plant we suggest be used for reproductive staging is influenced by our knowledge of the fruiting pattern. Although the main stem and basal primary branch carry the same number of pods on average, podding on the primary branches is concentrated within fewer nodes per branch than on the main stem (Erskine and Goodrich, 1990). Nodes 11 and 12 on the basal primary branch are the most commonly podded (Erskine and Goodrich, 1990). As a reference point spanning the most commonly podded nodes, the most advanced reproductive structure within nodes 10–13 on the basal primary branch will determine reproductive stage. For the purpose of describing the stage of reproductive growth, nodes on the basal primary branch are counted from the node on the main stem (node 0) subtending the basal primary branch.

The developmental stages of reproductive growth are given in Table 1. The R1 stage indicates anthesis and R2 represents full bloom with the spread of flowering from the first flowering node acropetally to nodes 10–13 on the basal primary branch. Stages R3 to R6 cover pod and seed development, stage R3 referring to first pod appearance on nodes 10–13 on the basal primary branch (Plate 3), stage R4 to the completion of pod growth (Plate 4), and stage R5 to

Table 1. *Reproductive stage of development descriptions for lentil*

Stage	Abbreviated stage title	Description of growth stage
R1	First bloom	One open flower at any node
R2	Full bloom	Flower open or has opened on nodes 10–13 of the basal primary branch
R3	Early pod	Pod on nodes 10–13 of the basal primary branch visible
R4	Flat pod	Pod on nodes 10–13 of the basal primary branch has reached its full length and is largely flat. Seeds fill less than half of the pod area but can be felt as a bump between the fingers
R5	Full seed	Seed in *any single* pod on nodes 10–13 of the basal primary branch are swollen and completely fill the pod cavity
R6	Full pod cavities	*All* the normal pods on nodes 10–13 of the basal primary branch are swollen and completely fill the pod cavity
R7	Physiological maturity	The leaves start yellowing and 50% of the pods have turned yellow
R8	Full maturity	90% of pods on the plant are golden-brown

Plate 3. Early pod stage (R3) (magnification × 2.2).

Plate 4. Flat pod stage (R4, left) and full seed stage (R5, right) (magnification × 3.5).

the completion of seed expansion within *any single* pod between nodes 10–13 on the basal primary branch (Plate 4). Stage R6 refers to the completion of seed expansion in *all* normal pods at nodes 10–13 on the basal primary branch (Whiting *et al.*, 1988). Stages R7 and R8 designate physiological and full maturity, respectively.

Stage of development of a community of plants

The stage descriptions apply to individual plants directly. To describe the stage of development of a community of plants, the stage designated should represent the average of the plants studied. The average stage of a field thus occurs when 50% of the plants are at or beyond a particular stage of development. Consequently, the developmental stage R1 or 'first bloom' corresponds to the stage commonly used in the field to estimate the time to 50% of the plants in flower. Obtaining a representative sample of plants requires inspection of plants from several locations in a field. At least one 10-plant sample for every 5 ha should be used to obtain an adequate determination of the average stage of development (Fehr and Caviness, 1977).

DISCUSSION

It is our belief that this uniform system for the description of developmental stages in lentil is universally applicable to all growing environments (field or greenhouse) and to divergent cultivars. Additionally, the descriptions may be used for single plants or communities of plants. The stage descriptions are precise and objective so that variation among those using the system will be minimal, thereby aiding communication between those interested in the ancient lentil.

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THE CRITICAL ZINC DEFICIENCY LEVEL AND RESPONSE TO ZINC APPLICATION OF WHEAT ON TYPIC USTOCHREPTS

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SUMMARY

Field experiments at 26 sites, selected on the basis of their varying degrees of zinc deficiency, showed that the critical deficiency levels of zinc for wheat were 0.60 mg kg^{-1} in the soil and 19 μg g^{-1} dry matter in 45-day-old plants. Further field trials at nine locations with varying levels of zinc deficiency showed successive increases in the grain yield of wheat with increases in zinc application, emphasizing the need for zinc fertilization when wheat is grown on zinc-deficient soils.

R. L. Bansal, S. P. Singh y V. K. Nayyar: *El nivel crítico de deficiencia de cinc y la respuesta ante la aplicación de cinc del trigo en typic ustochrepts.*

RESUMEN

Los experimentos de campo efectuados en 26 localidades, seleccionadas en base a sus diversos grados de deficiencia de cinc, indicaron que los niveles críticos de deficiencia de cinc para el trigo eran de 0,60 mg kg^{-1} en el suelo y 19 μg g^{-1} de materia seca en plantas de 45 días de edad. Posteriores ensayos de campo realizados en nueve localidades con distintos niveles de deficiencia de cinc dieron como resultado incrementos sucesivos en el rendimiento de grano del trigo al aumentar la aplicación de cinc, subrayando la necesidad de la fertilización con cinc para el cultivo del trigo en suelos con deficiencia de cinc.

INTRODUCTION

Zinc deficiency is widespread in India and has been reported in more than half the soils of the Punjab – the granary of India (Takkar and Nayyar, 1984). Since the introduction of the DTPA (diethylenetriaminepentaacetic acid) soil test (Lindsay and Norvell, 1978), several greenhouse studies have indicated the usefulness of this method for monitoring zinc deficiency in near-neutral and alkaline calcareous soils (Singh and Takkar, 1981; Singh and Shukla, 1985). However, little information is available on the applicability of the DTPA method to the determination of zinc availability for field grown wheat. In the present investigation, a critical value of available soil zinc for wheat was estimated from the response of wheat to zinc application on Typic Ustochrepts at Ludhiana, Punjab, India.

MATERIALS AND METHODS

Experiment I

To estimate the critical limit of zinc availability in soils, 26 wheat fields showing varying degrees of zinc deficiency symptoms were selected. The soils