Table 2.—Light interception efficiency indices of square and triangular stand geometries as compared to rectangular pattern.

| Stand geometries | CSH-3 | | Kovilpatti Tall | |
|---|---|---|---|---|
| | P1 33 | P2.67 | P1.33 | P2 67 |
| Square | 0.113[1] (0 192)* | 0 104(0 042) | —0 923(—0.030) | —0.475(—0.130) |
| Triangular | 0 305 (0 263) | 0 024(0 057) | —1.396(—0 312) | —0.529(—0 242) |

1/ Light interception efficiency indices for grain yield.

* Figures in parenthesis indicate light interception efficiency indices for biological yield.

producing photosynthates. The light interception efficiency with regard to biological yield was also favoured by triangular and square plantings at lower population and by square planting at higher population. With 'Kovilpatti Tall', the light interception efficiency indices under square and triangular plantings attained negative values indicating the superiority of the rectangular planting. This may be due to the stature of this tall hybrid the performance of which is probably governed by the inter-plant competition and other factors apart from the light interception and distribution in the canopy.

Although the study provides some basic information on the relative light interception efficiency of sorghum canopies of different structure, it is suggested that this expression (E) becomes more useful when the light interception observations are made at different stages of the crop growth and also at different heights within the canopy. Also, the light interception values in the present study are to be viewed relatively, as the absolute figures would be much higher.


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## Numerical characterization of the development of the bean plant (Phaseolus vulgaris L.)


**Sumario.** El desarrollo completo de la planta de frijol (**Phaseolus vulgaris** L.) se divide en ocho fases (I a VIII) que se pueden identificar a simple vista. El propósito de esta división es permitir una descripción objetiva para trabajos experimentales, independientemente del genotipo y del ambiente.


*Introduction*

In many experiments with beans, for instance in screening resistant genotypes through artificial inoculation, a bean scientist may have to closely follow the sequential stages of the ontogeny of bean plants, to intervene at the particular stage which he thinks most convenient for obtaining his objectives. In studying the effect of TIBA application on yield and protein content of *Phaseolus vulgaris* and *Vigna sinensis* cultivars, Rocabado and Pinchinat (1) have used the symbols $E_1$ and $E_2$ to designate respectively the first and third fully developed trifoliate leaf, $E_3$ for the first fully developed flower, and the symbol $E_4$ meaning 6-7 days after $E_3$. Unfortunately in many papers on dry bean mention is often made only of time of intervention, as in the following sentence picked up at random from bean literature "the treatments studied were one foliar application 10 days and two foliar applications 10 and 20 days after the emergence of the bean plants". Or else no mention at all is made, either of stage or of time, as in the following sentence: "groups of three plants, each one in a separate container, were inoculated according to the techniques established by . .".

The development of a bean plant may be considered as a sequential switch on and off of genes in a given environment. Saying that a particular intervention is made when the first trifoliate leaf is fully expanded, clearly indicates what genes are actually working or inactivated. At the same time a genotype and environment-independent description of the material is made. In wheat, such a description has been made possible by a numerical characterization of the development of the plant. Proposed in this note is a simple method to numerically characterize the ontogeny of a normal bean plant, illustrating the determinate growth habit.

## *Method*

The method consists of identifying eight growth stages, as follows:

Stage I : the dry bean seed, containing about 13 per cent moisture (Fig. 1a).

Stage II : or "knee-stage": the seedling has pushed up through the soil, the seed leaves still enclose the primary leaves and the hypocotyl presents the characteristic curving. The seedling is said to be kneed (Fig. 1b).

Stage III : the primary leaves are fully expanded (usually horizontal), the stem has elongated and the cotyledons, if still present, are drying up (Fig. 1c).

Stage IV : this stage is subdivided into sub-stages IV-1, IV-2, IV-3 and so on, with the arabic figures refering to the first, second, third . . ., fully unfolded trifoliate leaf (Fig. 1d).

Stage V : the first flower buds are appearing (Fig. 1e).

Stage VI : or "needle-stage": pods are forming. Since some portion of the style will remain as a filament at the end of the pod, this stage is called "needle" (Fig 1f).

Stage VII : the pods are drying.

Stage VIII: or "harvest-stage": nearly all pods have dried. Beans are usually harvested at this stage.

## *Discussion*

The proposed method is simple (a technical assistant will not have any difficulty in identifying a particular stage), objective (the identification is based upon clear-cut features of the ontogeny of the bean plant) and unambiguous (no two stages can be confused). Consider, for instance, stage V. Additional trifoliate leaves may be developing at the same time as flowers, but by definition the plant is in stage V and not in stage IV-5 for example. Moreover, additional flower buds may appear when pods are drying. In this case, the plant is in stage VII and not in stage V. Established in that way the method can also be used without any change for other bean growth habits, like indeterminate climbing.

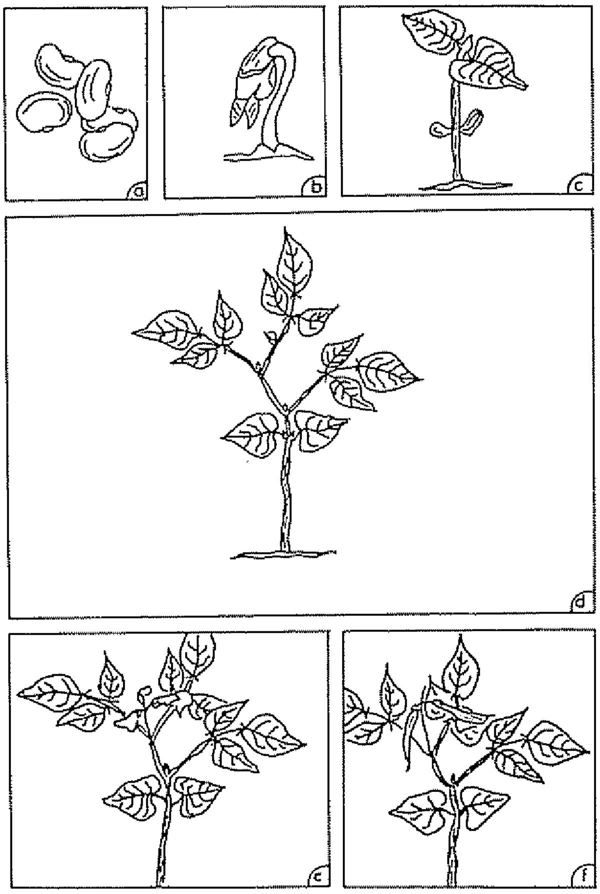


Fig. 1 —*Some stages of the development of a bean plant:* *a.* Stage I: *the dry bean seed with about 13 per cent of moisture;* *b.* Stage II: *the "knee-stage";* *c.* Stage III: *the primary leaves are fully expanded.* *d.* Stage IV: *the third trifoliate leaf is fully unfolded;* *e.* Stage V: *the first flower buds are appearing;* *f.* Stage VI: *the "needle-stage".*

The advantages of the method are evident. Bean scientist can describe bean growth stages independently of genotypes and environments. A better comparison of scientific results is allowed and long-word description are avoided.

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