Growth, Development, and Physiological Aspects of Mungbean Yield

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Introduction

There are several changes that take place in the life cycle of mungbean plant from germination to maturity. Shortly after emergence, the mungbean seedling become fully autotrophic, manufacturing its own constituents from carbon dioxide, water, and mineral elements, and transforming radiant energy into a usable chemical. Several physiological and morphological changes occur that involve the development of root, shoot and leaves, flowering, and seed formation. Each physiological and morphological characteristic may affect yield in many ways, the net effect of which depends on other characteristics, on environmental conditions, and on agronomic practices. Plant morphological characteristics and yield-forming components must be better understood if maximum yields are to be realized and exploited. When growth, development, and the physiological basis of yield are understood, it is possible to improve yields of a mungbean crop.

Growth and Development

The term growth is applied to quantitative changes occurring during development, and it may be defused as an irreversible change in the size of cell, organ, or whole plant. Plant development may be defined as the sequence of ontogenetic events, involving both growth and differentiation, leading to changes in function and morphology. The development of a mungbean plant usually proceeds in a most orderly sequence of changes, leading to an irreversible increase in size and a predictable alteration of form. Size may be measured as height, volume, or fresh or chy weights. Dry weight is usually preferred, it avoids complications arising from short-term fluctuations in water content and also gives a good indication of quantity of energy fixed. Development is most clearly manifest in changes in the form, as when it changes from a vegetative to reproductive stage and from reproductivity to maturity in mungbean plants.

The growth and development are operating together. They are mutually complementary and limiting. The mungbean is usually formed after adequate vegetative growth and timely development. Therefore, it is important to obtain adequate vegetative growth of leaf and stem before forming seed in order to obtain maximum yield.

A dry matter accumulation curve of mungbean is a typical sigmoid. In the beginning, there is slow accumulation of dry matter; but between 40 and 60 days of growth, there is almost linear increase in dry matter. This may be related to an increase in branching and leaf area during this phase of plant development. After 65 days of growth, the thy matter accumulation has more or less leveled off. Stress conditions occur during the grand period of growth (40-60 days), growth of the mungbean may be restricted and, consequently, lower seed yield occurs.

Growth Analysis

Growth analysis is the procedure of analyzing plant growth rate by expressing it as the algebraic product of a series of factors. Plant growth analysis is generally expressed in the indices of growth, such as crop growth rate, relative growth rate, net assimilation rate, leaf area index, and leaf area ratio. For growth analysis, only two types of measurement are needed: 1) the plant weight, which is usually the oven dry weight; and 2) the size of the assimilatory system, which is usually the leaf area. A brief discussion of important growth indices is given below.

Crop growth rate

The dry matter accumulation rate per unit land area is referred as crop growth rate (CGR), nonnally expressed as grams per square meter land area per day (g/land area/day). It can be calculated with the help of the following formula:

$$CGR = (W2 - Wl)/([SA] \times [t2 - tl])$$

where W1 and W2 are crop dry weight at the beginning and end of the interval, tl and t2 are corresponding days, and SA is the soil area occupied by the plants at each sampling.

CGR is normally low in the early growth stage and increases with time, reaching a maximum value at about the time of flowering. CGR helps in the interpretation of experimental results of different cultivars and other management practices. Mungbean CGR are usually in the range of 15 to 20 g/square meter land area/day.

Net assimilation rate

The dry matter accumulation per unit leaf area is termed as net assimilation rate (NAR) and is expressed as g/leaf area/day. The term represents net photosynthetic efficiency in the overall sense. It can be computed with the help of the following formula:

$$NAR = (1/A) \times (dW/dt)$$

where A is the leaf area and dW/dt is the change in plant dry matter per unit time. The objective of measuring NAR is to determine the efficiency of plant leaves in dry matter production. NAR decreases with crop growth owing to mutual shading of leaves and reduced photosynthetic efficiency of older leaves.

Leaf area index

Leaf area index (LAI) is defined as the leaf area per unit ground surface. This is basic to any analysis of community (stand) growth or light interception, and especially to the performance of net photosynthesis.

Plant productivity is defined in the sense of primary production of dry matter (biomass) at a given duration.. Thus the total plant dry matter production can be discerned from the view of growth analysis.

- productivity of a crop stand = production of dry matter of vegetation covering given area per unit of time

- dry matter production = NAR x LAI x time

  CGR (productivity) = dry matter production/time = NAR x LAI

NAR is a quantity which is influenced by efficiency of the canopy in light use. NAR and LAI together form a basis for productivity. However, high values of the above specific parameters of dry matter production or productivity do not necessarily contribute to high mungbean yield. The ratio of total dry matter production partitioning to the seed is another important parameter. Harvest index (HI) is defined as a ratio of seed yield over total dry matter production. HI are usually in the range of 20 to 45 in mungbean, depending on cultivar and management practices. High HI per se does not necessarily contribute to high mungbean yield. High mungbean yield is determined by high total dry matter production as well as high HI.

LAI is optimal for production when the light (active spectra for photosynthesis) is absorbed as completely as possible during its passage through the canopy of leaves. In stands of mungbean plants this is frequently the case with a LAI of about 2 to 4. If the density of foliage were less, the light available to individual plants, and thus NAR, would be greater, but with respect to the production per unit ground area an open stand to crops is less productive than a closed stand. If the plants are too closely spaced and the foliage overlaps too extensively, the light in the most shadowy places is no longer sufficient to keep the carbon-fixation balance positive at all times; thus the production per unit area will be reduced.

The density of the foliage of individual plants and the closeness of the plants (that is, the degree of cover) are more than just important factors affecting production - in fact, each itself affected by production. With an unfavorable fertilizer supply and scarcity of water, the plants lack the raw materials for the synthesis of an extensive leaf system, and the LAI remains insufficient.

Yield Components

Mungbean yield is predetermined by the potential of a given variety and the environment. At harvest, mungbean yield is usually expressed on a unit area basis rather than on a plant basis. It is it is determined by various ratios of yield components. Mungbean plants spend about half of their normal growing period with the useful component completely absent, whereas the rest establishes the yield component. A knowledge of formation and contribution of each yield component is essential for determining the mungbean yield.

With better understanding of the yield-forming capacity of mungbean, it is possible to design a blueprint for higher yield as well as timely planning of cultural practices to improve yields. The important yield components in mungbean are harvested plant number per unit area, number of pods per plant, seeds per pod, and weight of seed. Two main characteristics determine the eventual size of the yield component relative to the whole plant: 1) the time at which this component is initiated; and 2) the rate of growth of this component between the time of initiation and harvest relative to that of the rest of the plant.

The relationship between mungbean yield and its components can be expressed in the faun of the following equation:

Seed yield (t/ha) = no. of harvested plants/m2 x no_ of pods/plant x no. of seeds/pod x weight of 1000 seeds (g) x 10-5

To obtain a yield of 1.8 t/ha in mungbean, the following combination of yield components is required.

20 harvested plants/m2
15 pods per plant
10 seeds per pod
60 g weight of 1000 seeds

By putting these values into the following equation, the following results will be obtained:

Seed yield (t/ha) = 20 x 15 x 10 x 60 10-5 = 1.8

Each of the yield components differ not only in the time when determined, but in the contribution to seed yield. The number of plants per unit area are determined by the population density, and number of plants survived under disease or insect infested conditions. The number of pods are determined during vegetative growth stage, number of seeds per pod are determined during the reproductive stage, and seed weight during the ripening stage. If there is drought, and low solar radiation at the reproductive stage, the yield will be reduced much more than when with these stresses occur at the vegetative and ripening growth stages.

Yield components are not independent. They are also not passive participants in the determination of seed yield, but, on the contrary, exert an active influence on yield through the source-sink transport relationship. In general, an increase in one component at a certain level, often leads to a decrease in another. Often the number of pods per plant declines as the number of plants per unit area increases. Similarly, the weight per seed decreases as the number of seeds per pod increases. This means that, for maximum yield, all these yield components should in an appropriate balance.

A computation of yield components would be useful for deteinrining the target yield and examiningthe defects of a given crop if a comparison is made with a crop that has already achieved under a similar environment. Weather conditions, cultural management, and nutrient and water supply greatly influence each yield component. Understanding their relationship is a key to an increased mungbean yield.

Population Effects

Population pressures markedly affect yield performance. As plant population increases per unit area, a point is reached at which each plant begins to compete for certain essential growth factors: nutrients, sunlight and water. The effect of increasing competition is similar to decreasing the availability of a growth factor. There are two phases to this problem: 1) the effect of plant population per unit area (interplant competition); and 2) the effect of plant part number (interplant competition).

Since the land space and the fixed costs associated with it are usually much more valuable than the costs of individual plants, the most important consideration is the effect that varying the plant population has on the yield per unit area rather than on the yield per plant. The optimum population, therefore, is the one which produces the greatest net return to the grower. It should also be pointed out that yield must be interpreted in both quantitative and qualitative terms. The value of the total yield is not merely the total bulk, but is related to quality of the yield.