YIELD POTENTIAL VERSUS YIELD BARRIER IN GROUNDNUT

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The national average yield of groundnut among more than one hundred groundnut growing countries ranges between 300 kg h^{-1} and 5400 kg ha^{-1}. The average world groundnut yield is 1400 kg ha^{-1}. However, there are several documented cases in many countries including India where groundnut yields in excess of 9.5 t ha^{-1} have been realized in farmers' fields. Such values can be considered as representative of the yield potential of groundnut for the respective agro ecological zones. In India the average groundnut yield hovers around 1.0 t ha^{-1} in the rainy season (kharif) and around 1.5 t ha^{-1} in the post rainy season (rabi/summer). There remains a large gap (> 5.0 t ha^{-1}) between yield potential and the yield realized at the farmers' fields in India and other countries. This clearly suggests that the technology (non-genetic components) currently practiced by the general farmers only realizes partial yield potential of the existing varieties. Under such circumstances, the breeding for further increase in yield potential in a groundnut improvement program in developing countries where groundnut yields are generally low will not be advisable. Instead identification of barriers that limit realization of yield potential and their prioritization followed by resistance breeding for prioritized constraints should receive the most attention in a national breeding program. In many cases, a non-genetic option may be an easier and profitable solution. Socio-economic, policy and infrastructure related issues affecting groundnut productivity and production should be dealt with at the Government level so that impediments in reaping the benefits of research outputs by farmers are removed.

The stress resistance breeding entails a price- some sacrifice in yield potential. However, as the gap between yield potential and realized yield is large (>5.0 t ha^{-1}), it should not matter at the current status of groundnut cultivation in most of the countries. To keep the price of sacrifice in yield potential affordable, it will be essential to strike a proper balance between levels of resistance and yield potential. In most cases, a moderate level of resistance to stress factor(s) should suffice. However, for stresses that cause complete kill of the plant (such as peanut bud necrosis disease, groundnut rosette disease etc. in groundnut), a high level of resistance or even immunity will be required. The stress resistance breeding will help to increase and stabilize realized yield under low input rainfed farming conditions where more than 80% groundnut is grown. In addition, breeding for factors that affect the edible quality of produce including aflatoxin contamination will be essential to promote the edible use of groundnut as the oil use of the crop is showing a declining trend across the world.

Yield potential may be defined as the maximum yield obtainable by the best genotype available in a specified agro climatic environment when the known biotic and abiotic constraints are overcome. The ambient radiation, temperature and carbon dioxide regimes characterize the agro climatic environment. Soil physical characteristics are also important in the case of groundnut due to subterranean nature of podding in the crop. These environmental and soil factors place a limit to yield potential at a given location. Theoretically, the potential

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yield that can be reached in the crop in Shandong Province in China is 17.3 t ha^{-1}. There are two situations where further increase in yield potential is justified. These are i. where groundnut is grown in stress free environment, ii. where a ceiling is reached in realized yield.

Application of physiological models makes it possible to interpret genotype and environmental effects on yield, thus helps in assessing the scope for genetic improvement for a given trait. The yield potential of a genotype can be expressed through the following physiological model:

$$Y_R = C * D_R * P$$

Where, C mean crop growth rate, D_R duration of reproductive growth, and P= mean fraction of C partitioned towards the reproductive organs.

C is defined as dry matter produced per unit land area per unit time (g m^{-2} day^{-1}). It is the integration of intercepted radiation and radiation use efficiency. D_R and P are the integration of period of reproductive growth and ability of partitioning of photosynthates to pods. The crop duration is generally fixed for a given location or cropping system. It is determined by soil moisture availability and prevailing temperatures during the cropping season. D_R can be increased to some extent by reducing the duration of the vegetative phase by selecting for early emergence and profuse early flowering. Thus, in a fixed crop duration, C and P are the major determinants of the final yield.

The variations in C are dominated by environment and genotype x environment interactions. Variation in radiation use efficiency, a determinant of C, is small under non-limiting conditions in a species. The scope for variation in intercepted radiation, another determinant of C, is large and can be manipulated by ensuring early ground cover. At a leaf area index (LAI) of 3.0 to 3.5, 95% radiation is intercepted. At full energy interception, C depends on availability of water and D_R. In groundnut, both genotypic and photoperiod differences are important sources of variation in P. At full radiation interception, P is the major source of variation in yield under non-stressed conditions. In the USA, the progressive increase in yield in successive variety releases was associated with improvements of P and an earlier transition to reproductive growth, while C remained constant.

The breeding programs should be targeted to specific environments and so should be the evaluation system of breeding lines leading to local or regional variety releases. The duration of new breeding lines should match with soil moisture availability period and they should carry resistance/tolerance to important biotic/abiotic constraints operating locally. Both improved cultivars and improved cultural practices not only contribute significantly towards increase and stability of yield but they also have a synergistic effect. Research on water and nutrient management has not received adequate attention in India. Most of the recommendations are very general in nature and do not address location specific issues associated with cultural management. The management practices should be not only location specific but also variety specific.

In summary, the national groundnut breeding programs in developing countries including India should first focus on prioritized stress factor(s) resistance breeding including factors that affect edible quality. The crop management research should also get equally high priority in the national programs so that improved varieties and improved cultural practices could contribute synergistically to groundnut productivity. Only when a ceiling in realized yield is reached, should the breeding for increased yield potential be undertaken.

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