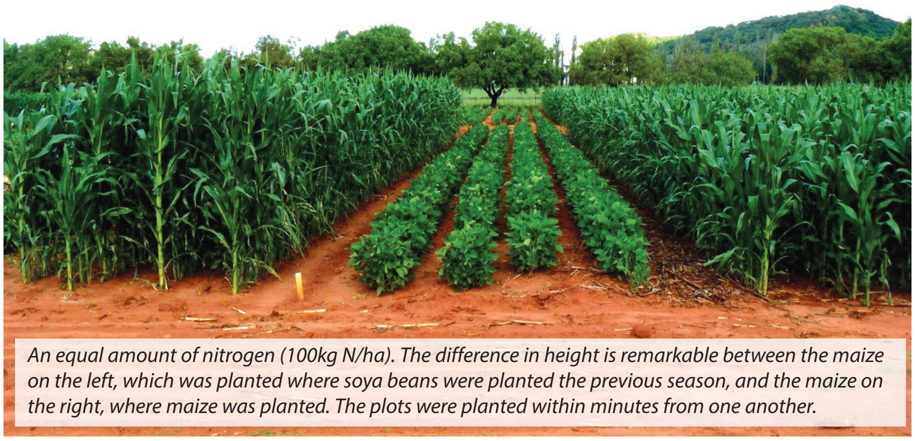
By Dr Johan J van Biljon, Yield-enhancing Systems: Kynoch Fertilisers (Photographs supplied by Wessel van Wyk, soya bean specialist, Protein Research Foundation)

Nitrogen fertilisation of soya

As soya bean is a legume that can fix atmospheric nitrogen (N), it is commonly accepted that it is not necessary to fertilise soya with this chemical element. This position, however, is increasingly being questioned and is currently a very controversial topic.



An equal amount of nitrogen (100kg N/ha). The difference in height is remarkable between the maize on the left, which was planted where soya beans were planted the previous season, and the maize on the right, where maize was planted. The plots were planted within minutes from one another.

The general belief is that soya reacts well to residual soil fertility. In addition, it is accepted that soya is able to absorb sufficient nitrogen through *Bradyrhizobium* bacteria for an optimal yield and still leave enough of the chemical element for the following crop.

Nel (2016) found that soya is effectively nitrogen neutral. This means the soya plant does not leave extra nitrogen in the soil for the following crop. To the contrary, there are cases where less nitrogen was being left in the soil compared to that with which it commenced growth. Other researchers have achieved similar results and these question the old beliefs, causing the controversy.

Crop rotation is used worldwide to decrease risk in crop production and to produce sustainably. In South Africa we, in general, make very little use of crop rotation and often pay the price. The most common crop rotation programmes rotate monocotyledonous crops (such as maize, grain sorghum and wheat) with dicotyledonous crops (such as soya beans, cowpeas and even groundnuts). The use of a maize-sunflower rotation system will most probably not have the desired effect as the two crops have susceptibility to certain diseases in common.

Crop rotation

Using crop rotation holds various advantages. The root systems of the two groups of crops differ. These differences can achieve physical variations in soil profiles, in that the roots feed on different nutrients at different depths.

Maize-on-maize on the left and maize-on-soya bean planting on the right. A visible difference!

The variations in root systems can possibly improve the recycling of nutrients throughout the soil profile, which could potentially improve yields. Unfortunately, it is also true that by continuing to plant the same crop, certain zones in the soil become depleted of nutrients over time.

The principal advantage of crop rotation most probably lies in the reduction of disease and pests. When different groups of plants are grown, the survival of diseases and pests decreases. With monoculture of, for instance, maize over many years, the incidence of root diseases becomes common. In contrast, a well-planned crop rotation system will significantly curtail these root diseases.

By decreasing the occurrence of root diseases, the efficiency of the maize plant's root system can be increased significantly, and this could be a main reason why maize plantings following soya perform better than maize on maize. The higher yields of maize following soya plantings are therefore most likely not due to transferred nitrogen, but rather the result of other crop rotation effects.

New cultivars

A possible additional contribution to the controversy could be the yield potential of new cultivars which is higher than older ones, and that current guidelines should be adjusted. Soya beans remove between 75 and 105kg N/ton grain (MVSA, 2007), which means, using 90kg N/ton, a 3,5t/ha harvest will remove 315kg N/ha.

Maize plantings after soya beans – no shortage of nitrogen.

Maize plantings followed by maize – visible nitrogen shortages.

The difference between maize on the left, where soya beans were planted the previous season, and maize-maize plantings on the right.

Salvagiotti, et al., (2008) found that nitrogen fixing can provide for around 50 to 60% of the soya plant's nitrogen needs in a 3,5t/ha yield. If 60% of a 3,5t/ha yield can be obtained this way, it implies that there is a shortage of 126kg N/ha (40% of 315) that must be acquired elsewhere.

Foreign information

The International Plant Nutrition Institute (IPNI) (2012) reports that the University of Nebraska has studied 108 scientific articles on the nitrogen fertilisation of soya beans. In approximately 50% of the cases there was a positive reaction to nitrogen fertilisation. In twelve experiments the yield exceeded 4t/ha and 75% of the experiments reacted positively to nitrogen fertilisation. The economic viability should, however, be monitored closely and will be determined by the soya-nitrogen price ratio.

Kaiser, et al., (2011) found that should good nodulation not take place and should the nitrate-nitrogen level be less than 84kg/ha up to a soil depth of 600mm, between 55 and 85kg N/ha should be applied.

Local information

The fertilisation guidelines of the Fertiliser Association of Southern Africa (Fertasa) (2007) state that an increase in yield with nitrogen fertilisation is unlikely where soya bean plants have been inoculated properly, and where growth conditions are favourable. It is mentioned, however, that an initial nitrogen fertilisation of 10 to 20kg N/ha should be beneficial, especially on sandy soils.

Soya beans are dependent exclusively on soil nitrogen during the vegetative phase (four to five weeks after emergence), after which biologically bound nitrogen can be utilised by the plant (Botha et al., 1996). During the pod-filling stage (R5 to R6) the supply from the nodules decreases and nitrogen supply to the seeds is obtained from either the plant itself or from soil nitrogen.

Additional work by Botha et al. (1997) determined that nitrogen application during the V1 growth stage, increases the number of pods, seeds, leaves as well as seed mass, and increases the total nitrogen and protein production. Nitrogen application in the R2 growth phase had little effect on seed yield and protein quality.

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With nitrogen application during the R4 growth stage, when atmospheric nitrogen is being actively fixed, seed yield, biological nitrogen binding, soil nitrogen intake and protein production were inhibited. Seed mass and protein production, however, increased with nitrogen application in the R5 growth stage. The conclusion of the authors was that the application of 40kg/ha of nitrogen during the V1 and R5 growth stages could be beneficial.

Where does this leave us?

Until more information becomes available, it seems that for soya beans – especially where organic matter in the soil is low and/or where soil fertility (in acid soils) is inadequate – an initial application of at least 10 to 20kg N/ha should be applied. For yields of more than 3 to 4t/ha, it should be advantageous to apply 30 to 40kg N/ha during pod-filling stage (R4 to R5).

Under irrigation, with targeted yields of 6t/ha and more, the nitrogen application should be much higher. These are preliminary indications, and the validity thereof should be investigated with long-term experiments on the same plot within a crop rotation system.

References are available from the author.