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A More Complete Definition for Promiscuous Soybean

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Abstract

Following a series of research on promiscuous nodulation, it came out that it is incomplete to define '*promiscuous soybean*' as soybean cultivars with the sole ability to form nodules freely with indigenous *Bradyrhizobium* strains without requiring the specific type, *Bradyrhizobium japonicum*. This paper proposes a more complete definition which caters for both nodulation and biological nitrogen fixation ability.

Keywords : Promiscuous soybean; Nodulation; Biological nitrogen fixation; *Bradyrhizobium*

Context

Soybean (*Glycine max (L.)* Merrill) is an annual legume crop, widely grown in tropical, subtropical and temperate regions throughout the world. It accounts for about 84.5% of the world grain legumes trade [1]. Though soybean is easily introduced in places where it is not native, its production in such places (especially in Africa) is challenged by the lack of *Bradyrhizobium japonicum* and *Sinorhizobium fredii*. In fact, soybean belongs to the third group of legumes whereby plants can form nodule effectively with specific strains only. Legumes of this group include: *Coronilla, Glycine max, Lens, Leucaena, Lotus, Phaseolus, Pisum, Trifolium Lupinus, Medicago, Melilotus [2]*. Being a nodulating legume crop and given its high protein content, soybean plants have a high nitrogen demands to construct an equally high concentration of protein (40% in soybean grain) [3]. According to Machido et al. [4], soybean crop requires high doses of nitrogen mostly at pod filling stage in order to construct an equally high concentration of grain proteins. It has been reported that soybean requires approximately 80kg of nitrogen for each metric tonne of grain yield. For instance, Salvagotti et al. [5] noted that, soybean yielding 5t ha^{-1}, takes up about 400kg of nitrogen. Due to the low available nitrogen in most soils, soybean needs to fix more than half of its nitrogen requirement through biological nitrogen fixation. Salvagotti et al. [5] reported the need for 58% nitrogen coming from biological N_2 fixation.

Bradyrhizobium japonicum and *Sinorhizobium fredii* are not native in most tropical African soils, Abaidoo et al. [6] reported about 74% of the African soils having *Bradyrhizobium* spp. populations which is different from *Bradyrhizobium* japonicum and do not cause nodulation in most soybean plants. Interstingly, researchers at IITA have found alternative in developing tropical African soybean cultivars. They are meant not to be specific to *Bradyrhizobium japonicum*, and can easily form nodules with the native *Bradyrhizobium* strains [7]. Such cultivars are termed 'promiscuous' soybeans. Although they are reffered to as freely nodulating or easily nodulating cultivars, the term promiscuous soybean predominate. Pulver et al. [8] defined promiscuous soybean as soybean cultivars that have the ability to nodulate with indigenous *Bradyrhizobium* strains. However, nodulation would be useless if not accompanied by sufficient biological nitrogen fixation. Hence we believe the definition needs to be improved to cater for biological nitrogen fixation aspect, as it is the ultimate goal of nodulation.

Definition

Rather than reffering to the ability to mutiple associations with *Bradyrhizobia*, promiscuity in soybean rather hints at the ability to form nodules easily or freely with the available *Bradyrhizobium* and not requiring any specific *Bradyrhizobium* type. Taking that as reference, Agoyi et al. [9] conducted a series of research ranging from screening of soybean genotypes for promiscuous nodulation Agoyi et al. [9] to assessement of their ability to fix sufficient amount of nitrogen while in symbiotic association with indigenous (non specific) *Bradyrhizobium* types [10].

Based on the fact that all the promiscuous genotypes identified in the studies were capable of fixing substantial amount of nitrogen with both *Bradyrhizobium* strains used and especially with the indigenous type *Bradyrhizobium spp*., "promiscuous" soybean cultivars can be best defined as soybean genotypes that have capability to form nodules and fix nitrogen in symbiotic association with one or more indigenous *Bradyrhizobium* strains, in absence of the specific *Bradhyrizobium japonicum*. This definition caters for both nodulation and biological nitrogen fixation abilities.

Conclusion

Promiscuous nodulation in soybean is not merely the ability of soybean plants to form nodules with a more than one soil bacteria type, neither it is sufficient to define it as the sole ability of soybean plants to form nodules with indigenous and readily avialable Bradyrhizobium strains. A complete definition should refer to the ability of soybean plants to forms nodules with indigenous readily available Bradyrhizobium strains, or engage in multiple associations with Bradyrhizobium strains to form nodules and at the same fix a sufficient amount of nitrogen as a result of effectiveness of the population of Bradyrhizobia that colonized the root system. Hence, this paper recommend that before a soybean cultivars be termed as promiscuous, both nodulation ability without requiring the specific type Bradhyrizobium japonicum and nitrogen fixing ability while in symbiotic association with that non specific Bradhyrizobium should be tested.

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