Endophytes – a boon for groundnut cultivation in drought-affected areas

Situation Analysis:

With the changing climatic scenario, it is predicted that there will be increase in frequency and intensity of stresses, particularly drought, affecting productivity. As a result, vast stretches of arable land are likely to be further added to the already existing 40% of global land under arid and semi-arid areas. As groundnut is predominantly a rainfed crop grown in semi-arid tropics, and susceptible to drought, productivity of groundnut may reduce drastically because of inadequate and uneven distribution of rainfall in different parts of country. Even there are instances of total failure of groundnut crop because of drought in drought-prone areas like Anantapur district of Andhra Pradesh, the largest groundnut-growing district in India, affecting livelihood of farming community. Moreover, to enhance production of groundnut in India, we need to manage drought and produce more in semi-arid and rain-fed systems. However, because of non-availability of truly drought tolerant groundnut cultivars, alternate management strategies are required to contain drought. As endophytic microorganisms are believed to have co-evolved with plants and helped them in acclimatizing and circumventing the extremities of terrestrial ecosystem during their transition from aquatic life, this group of organisms can be exploited to alleviate drought and prevent reduction in yield.

Endophytes: the savior

Impact of endophyte on pod yield of groundnut without any supplementary irrigation

The bacterial endophytes have been isolated and identified at ICAR-DGR, Junagadh. Their evaluation under stringent condition of drought during summer seasons at Junagadh showed promise of alleviation of drought and prevention of yield loss of groundnut. Application of endophytic bacteria like *Bacillus firmus* J22, *Bacillus subtilis* REN51, and *Pseudomonas pseudoalcaligenes* SEN29, prevented the loss of yield of groundnut by 15-25% as compared to uninoculated control, with the application of a single irrigation at the time of sowing, and no irrigation thereafter with cultivar TG37A during successive summer seasons (Figure 1). Though yield in untreated control drastically reduced, application of endophytes like Ba*cillus firmus* J22, a seed endophyte; and *Pseudomonas pseudoalcaligenes* SEM29, a stem endophyte prevented the loss of yield significantly.

Field evaluation of endophytes with single supplementary irrigation at 55 DAE with cultivar TG37A

With single supplementary irrigation at 55 DAE, the application of these endophytes were able to prevent yield loss to the tune of 17-25% over control (Figure 2).

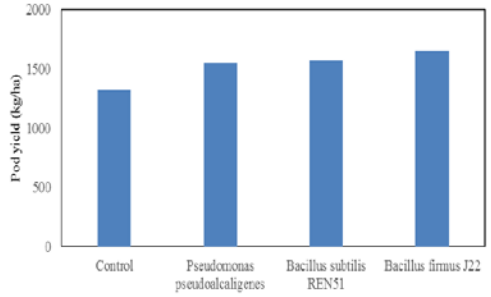

Figure 2. Impact on pod yield of groundnut with inoculation of endophyte and single supplementary irrigation with cultivar TG37A

Water saving:

Summer groundnut is raised with the application of 10-12 irrigations depending upon soil type. But with the application of drought-stress alleviating endophytic bacteria, it was found that at least 5-6 irrigations can be saved without drastic reduction in pod yield (Table 1). Therefore, the saved water can be utilized for horizontal expansion of irrigated area and thus total production can be improved substantially. Whereas application of three protective irrigations after emergence with endophytes like *Pseudomonas pseudoalcaligenes* SEN29 and *Bacillus firmus* J22 gave 2260-2309 kg/ha of pod yield, crop raised with 10 irrigations after emergence gave 2233-2483 kg/ha, and the difference is not significant. Thus, with the water saved, at least one more ha of land can be cultivated. Thus, double the area can be cultivated with same available water with the application of endophytic bacteria.

Table 1. Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2016; TG37A)

Treatments	**No of supplementary irrigations after emergen**				**Mean**
	1	**2**	**3**	**10**	
Control	1312	1523	2065	2113	**1753**
Bacillus firmus J22	1724	1719	2260	2333	**2021**
Bacillus tequilensis SEN15	1578	1741	2277	2374	**1992**
Pseudomonas pseudoalcaligenes SEN	1558	2000	2309	2483	**2075**
Mean	**1543**	**1745**	**2228**	**2326**	**1961**

Impact in farmers' field:

Demonstration of the effectiveness of endophytes in enhancing yield of groundnut with protective irrigation was made in the farmer's field (Mr. Lakshmikant Reddy) at Anantapur District with 22 acres with cultivar Kadiri 9 during kharif season of 2016. There was rainfall of 180 mm and two protective irrigations were provided to the crop. There was yield enhancement to the tune of 32% with the application of *Bacillus firmus* J22 and *Pseudomonas pseudoalcaligenes* SEN29 (Figure 3).

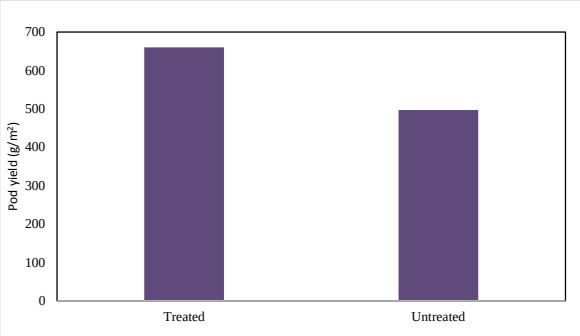

Figure 3. Impact of application of endophytes in enhancing the yield of summer groundnut at farmers' field at Anantapur

Demonstrations conducted during kharif 2017 in farmers' fields at Anantapur strictly under rainfed condition revealed that under rainfed condition (around 500 mm of precipitations received), application of *Bacillus firmus* J22 improved the yield of groundnut (cultivar Kadiri 6) by 36%

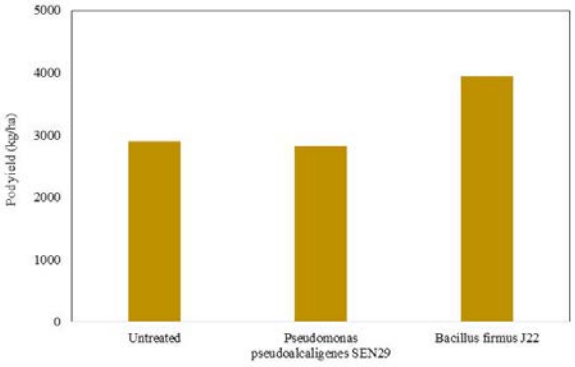

Figure 4. Impact of application of endophytes in enhancing yield of rainfed groundnut in farmers' field at Anantapur, AP during kharif 2017, cultivar Kadiri 6

The endophytes are now being evaluated in historically drought-prone areas of India under AICRP-G.

About the endophytes and their availability:

Bacillus firmus J22 is a seed endophyte of groundnut, which is also capable of colonization in root and stem. *Pseudomonas pseudoalcaligens* SEN29 and *Bacillus subtilis* REN51 are predominantly stem and root endophyte of groundnut, respectively. However, all these endophytes are capable of colonizing in other plant tissues and perpetuates through seeds. Now, formulation of *Bacillus fir mus* is underway and on the basis of recommendation from AICRP-G trials, the technology will be transferred to interested entrepreneurs. Thus, application of *Bacillus firmus* J22 will be a focal point in alleviating drought stress in groundnut, particularly in historically drought-prone groundnut cultivation areas in India.

Trial is in progress on alleviation of drought stress in groundnut by application of endophytic bacteria at Hiriyur, Karnataka (kharif 2016)