On-farm seed priming reduces risk and increases yield in tropical crops

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Abstract

Poor crop establishment is a major problem in many areas of the world, particularly for subsistence farmers in rainfed- and poorly-irrigated environments. 'On farm' seed priming – soaking seeds, usually overnight, before sowing – is a simple technology that farmers can use to improve crop establishment and increase yield. It has been tested, developed and refined in a range of crops, countries and agro-environments using a combination of *in vitro*, on-station and farmer-participatory research and regularly increases yield. In addition, priming has been associated with increased disease resistance in some crops and can also be used as a vehicle to alleviate some micronutrient deficiencies.

Media summary

'On-farm' seed priming is a low-cost, low-risk technique that is easily adopted by resource-poor farmers in developing countries and increases the yield of tropical crops.

Key words

On-farm seed priming, crop establishment, tropical crops.

Introduction

For resource-poor farmers in developing countries who grow annual crops from seed, good stand establishment is of paramount importance because patchy stands result in low yields and, often, crop failure. Even if sparse crops can be re-sown, it is expensive and can lead poor farmers into crippling debt. Good crop establishment is especially difficult in marginal, rainfed environments where many poor farmers live. Unpredictable and erratic rainfall, poor soils, low-quality seed and limited availability of labour or draft power all contribute to a situation in which good crop establishment is often the exception rather than the rule (Harris, 1992; 1996). Since 1990, on-farm priming of seeds of a range of tropical and sub-tropical crops has been tested as a means to promote rapid germination and emergence and to increase seedling vigour and hence yield.

Methods

Initially, *in vitro* experiments to determine the optimum priming characteristics of the most important tropical and sub-tropical annual crops were implemented and the results are summarised by Harris and Mottram (2004). In essence, it is safe and effective to soak seeds of most of the crops listed in Table 1 (and also others reported by Harris and Mottram, 2004) for 8 to 10 hours, followed by surface drying and immediate sowing. Exceptions are rice and maize that can be soaked for longer, e.g. 16-18 hours.

A combination of on-station and participatory, farmer-managed, on-farm trials was then used to assess the performance of seed priming in various crops and countries. Further details and results of these trials series may be found in the references listed in Table 1.

Results and discussion

Development and yield

On-farm seed priming was found to be effective in increasing yields in all the crops and countries listed in Table 1. Crops include both cereals and legumes and mean yield increases due to priming range from zero to more than 200%, with an overall average increase of around 30%.

Table 1. Crops in which seed priming has been tested successfully, the countries involved and the references where the methods used and the results obtained can be found.

Crop	Countries	References
Wheat	India, Nepal, Pakistan	Harris *et al*. (2001b); Rashid *et al*. (2002)
Upland rice	India, Nigeria, Sierra Leone, Gambia, Ghana, Cameroon	Harris *et al*. (1999); (2002); Harris (2003)
Maize	India, Nepal, Pakistan, Zimbabwe	Harris *et al*. (1999); (2001a); (2001c)
Sorghum	Pakistan, Botswana, Zimbabwe	Harris (1996); Chivasa *et a*l. (1998); (2001); Rashid *et al*. (2002)
Pearl millet	Pakistan, India	Harris and Mottram (2004)
Finger millet	India	Kumar *et al*. (2002)
Chickpea	Bangladesh, India, Nepal, Pakistan	Harris *et al*. (1999); Musa *et al*. (2001); Rashid *et al*. (2002)
Mungbean	Pakistan	Rashid *et al*. (2004b)
Cowpea	Senegal	Braconnier and Bouru (2004)

Disease resistance

Musa *et al*. (2001) reported that seed priming in chickpea significantly reduced the damage caused by collar rot (*Sclerotium rolfsii*) in Bangladesh in two contrasting seasons. Recent work in Pakistan has demonstrated that mungbean (*Vigna radiata*) grown from seed primed in water for 8 hours before sowing showed significantly fewer serious symptoms of infection by Mungbean Yellow Mosaic Virus (MYMV) than a crop established without priming (Figure 1). The large differences in virus-related damage were associated with significant increases in pod weight (threefold) and grain weight (fivefold) due to priming (Rashid *et al*., 2004a). Rashid *et al*. (2004b) also observed similar differences in MYMV infection in other mungbean priming trials.

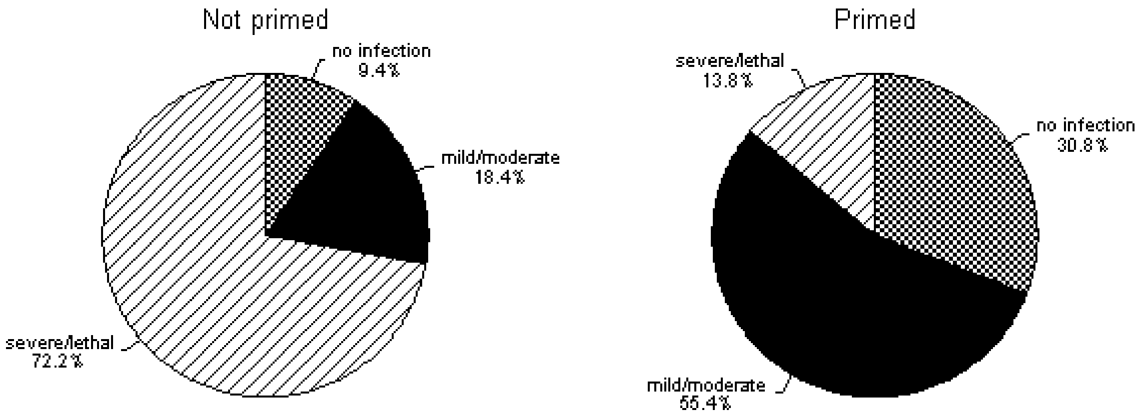

Figure 1. Proportion of mungbean (*Vigna radiata*) plants showing no symptoms (stippled), mild symptoms (solid) and severe symptoms (line shading) of Mungbean Yellow Mosaic Virus in Peshawar, Pakistan. Crops were grown either without seed priming (left) or seeds were primed in water for eight hours before sowing (right)

Micronutrient provision

Many legumes are relatively unproductive in acid soils because nodulation is limited by poor availability of molybdenum (Mo). In particular, chickpea is known to respond to added Mo but soil application is problematic for resource-poor farmers because of the relatively high rates of application required (at least 0.5 kg/ha) and because uniform application is difficult to achieve. Several authors have shown that it is possible to introduce Mo into seeds in aqueous solution, i.e. by priming (Johnson, 2004; Kumar Rao *et al*., 2004). The effect of sodium molybdate added to soil (500 g/ha) was compared to priming seeds with the same material but using only 0.5 g/l (approximately equivalent to 40 g/ha) in 19 trials in 5 villages in Jharkhand and West Bengal states in India in the 2003-2004 *rabi* season. Large areas of these and other eastern Indian states are used to grow rice during the rainy *kharif* season but are generally left fallow during the following *rabi* season, even though there is abundant residual soil moisture (Subbarao *et al*., 2001). The soils are mostly acidic and chickpea is known to respond to Mo when grown in pots containing soils from this area (Kumar Rao *et al*., 2004).

Each trial contained three plots – the two Mo treatments and a plot without any added Mo. Seed in all plots was primed for eight hours and was inoculated with Rhizobium culture. Nodulation was assessed in each plot using a standardised index based on photographs of a range of nodule abundance with values from 0 to 5. There was a clear response to Mo added during the priming operation (Table 2)

Table 2. Nodulation of chickpea in response to added molybdenum in 19 farmers' trials in five villages of Jharkhand and West Bengal states, India.

Molybdenum treatment	Mean nodulation index (0 -5)
No added Molybdenum	0.95
Molybdenum added to priming water	1.61
Molybdenum added to soil	1.18

SE diff. (36 df)	0.143

whereas the effects of soil application were not significantly different from the control treatment. Yield data are not available at the time of writing but observations suggest that yield will be significantly increased in both Mo treatments.

Risk

Conducting large numbers of farmers' trials allows the risk of failure in priming seeds to be assessed (e.g. Harris, 2002; 2003). Figure 2 shows that the risk of a negative consequence of seed priming in chickpea was less than 2%, which suggests that seed priming is a very safe practice. A similar estimate of the risk associated with seed priming for upland rice has been calculated using data from more than 900 farmers' trials in West Africa (data not shown).

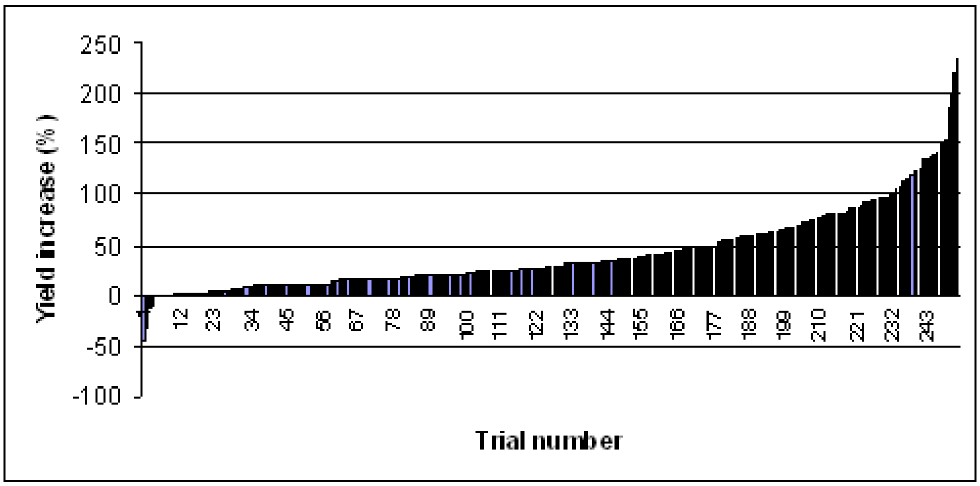

Figure 2. Yield advantage (%) of using primed seed over non-primed seed of chickpea in 253 farmer-participatory, paired plot trials in Bangladesh and Nepal.

Conclusions

On-farm seed priming is safe, effective and easily adopted by resource-poor farmers and has the potential to benefit such farmers in many ways. More work is required to clarify the mechanisms by which priming affects development, growth and disease resistance and to refine methods for low-cost alleviation of some micronutrient deficiencies.

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