Response of Chickpea to Seed Priming in the High Barind Tract of Bangladesh[1]

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The Barind Tract comprises uplifted weathered alluvium of high clay content, which is not subject to annual flooding by the major river systems in northwestern Bangladesh. The undulating or High Barind Tract (HBT) covers some 2200 km^2 to the west of this region (Edris 1990). The traditional cropping system of this area is predominantly rainy season rainfed transplanted *aman* (t. *aman)* rice, which is transplanted in July and harvested in October-November. The bunded fields were invariably left fallow for the remainder of the year. However, on-farm research initiated in the 1980s by the On-Farm Research Division of the Bangladesh Agricultural Research Institute, and carried forward by them, has developed and demonstrated technology that permits cultivation of winter (postrainy season) crops to follow rice (Kumar et al. 1994). Essentially, this involves seed bed preparation and sowing of the postrainy season crop soon after harvest of rice while the soil surface retains sufficient moisture to ensure adequate crop establishment. Seedling roots penetrate the then moist plow-pan layer and can then extract residual soil moisture from deeper layers after the surface soil and plow-pan layer dries out. If shorter-duration varieties of postrainy season crops are used they can reach maturity before the residual subsoil moisture is exhausted. Also, if shorter duration *t. aman* rice varieties are used, or the rice is transplanted earlier than normal or directly seeded, rice maturity can be reached at an optimum sowing time for postrainy crops (their late sowing, in late November or early December, retards vegetative growth and root penetration and hence they face a greater degree of terminal drought stress).

Chickpea (*Cicer arietinum* L.) has proven to be particularly suited to growing after rice in this system because of its strong rooting characteristics and because of the availability of shorter-duration improved varieties, as compared to traditional local landraces now used. The area of chickpea in the HBT in the 1984/85 season was around 1200 ha but in 1997/98 it was estimated to be 9000-10 000 ha (Musa et al. 1998). Chickpea yields in the HBT are usually more than the national average due to low incidence of botrytis gray mold disease in this region. However, yields in most farmers' fields normally remain below 1 t ha^{-1} due mainly to crop establishment problems and terminal drought and heat stress.

In on-farm trials in western India, it has been reported that seed priming increases yields of chickpea and other rainfed crops (Harris et al. 1999). The priming process simply involves soaking the seeds overnight (for about 8 h), surface drying them, and then sowing within the following day. This treatment hastens germination, enhances crop establishment and promotes seedling vigor (Harris et al. 1999). It was therefore considered worthwhile to evaluate seed priming for its efficacy for chickpea grown in the harsh conditions of the HBT.

On-farm trials were conducted under dryland conditions at 30 locations in the Ataher, Amnura and Nachole soil series of the HBT. About 0.13 ha of land at each location was divided equally for the following two treatments: 1) non-primed, where normal dry seeds were sown; and 2) primed, where seeds were soaked in water overnight, surface dried, and then sown within that day. Farmers were appropriately trained in this methodology. The chickpea variety Barichola-2, recently released for cultivation in Bangladesh was used as the test crop and sown at the seed rate of 50 kg ha^{-1}. Several participating farmers applied P_2O_5 at 40 kg ha^{-1}, as triple superphosphate, and K_2O at 20 kg ha^{-1}, as muriate of potash. No fungicidal seed dressing or *Rhizobium* inoculation was used. Fertilizer was applied at the time of land preparation, by power tiller or bullock-drawn plow followed by laddering (leveling). Seed was hand broadcast in each treatment plot at the same time followed by a final laddering. The sowing date for the different locations ranged from 19 Nov to 13 Dec 1998, Intercultural operations for weed control were done as needed and some farmers applied need-based sprays of insecticide to control *Helicoverpa armigera* pod borer.

During the crop growth period, observations were made on such parameters as emergence, early growth vigor and pest and disease incidence. Plots with the priming

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Table 1. Summary of data from 30 locations on effect of seed priming on chickpea performance in the High Barind Tract of Bangladesh, 1998/99 season.

Variable	Mean primed	Mean non-primed	Increase associated with priming (%)	Probability (paired t-test, 2-tailed)	Significance[1]
Emergence, plants m^{-2}	36.7	30.2	21	1.51E-08	***
Early growth, plant height (cm)	10.5	8.6	22	1.47E- 12	***
Plant height at harvest (cm)	36.4	33	10	1.17E-07	***
No. of diseased plants m^{-2}	1.1	2.0	-45	2.87E-05	***
Pod borer damage, damaged pods m^{-2}	3.6	4.1	-13	0.366	ns
No. of unfilled pods $plant^{-1}$	3.4	4.4	-21	0.1287	ns
No. of plants at harvest m^{-2}	30.6	25.0	22	2.56E-07	***
No. of pods m^{-2}	1493	1074	39	4.09E-05	***
1000 grain mass (g)	117.7	111.3	6	0.0734	ns
Grain yield (t ha^{-1})	1.63	1.11	47	1.96E-05	***
Residue yield (t ha^{-1})	2.0	1.53	31	2.94E-05	***

1. *** = Significant difference at $P<0.001$; ns = difference not significant.

treatment were harvested during 20 Mar to 4 Apr for the different locations, and plots without primed seed were harvested during 25 Mar to 7 Apr 1999. The primed seed plots were harvested 3-7 days before their respective non-primed ones, but dates of physiological maturity for each plot were not recorded. Data on yield and yield components for each plot were collected and analyzed, initially by a paired two-tailed "t" - test using all 30 locations.

Rainfall continued until mid-November in 1998, thus delaying maturity and harvest of rice and consequently sowing of chickpea crops. However, from 22 Nov, there was no effective rainfall recorded for the entire chickpea growth period. Thus the chickpea crops in this study grew entirely on residual stored soil moisture.

Seed priming resulted in earlier emergence of seedlings, by 1-3 days, and significantly increased (mean across 30 locations) plant stand and initial growth vigor (Table 1). There was much less incidence of soil-borne disease, mainly caused by collar rot (*Sclerotium rolfsii*) and *Fusarium* spp. in primed plots than in non-primed plots (Table 1). There also appeared to be less pod borer damage and fewer unfilled pods in primed plots, but the effect was not significant when all 30 locations were considered (Table 1). Although not all plots were examined, primed plots generally seemed to have better nodulation, by natural rhizobia. Nodule number per plant ranged from 7 to 51 in primed plots and from 6 to 18 in non-primed plots. It was also noted that nodulation was generally better in plots in lower catena soils (Nachole soil series) than soils higher in the catena (Ataher and Amnura series); biomass and grain yields followed a similar trend.

Priming of seeds resulted in an overall 47% grain yield advantage, with all yield contributing factors measured showing positive effects of priming (significantly for all parameters except 1000 grain mass) (Table 1). This is only the first year of the seed priming study in this region but the results indicate dramatic effects on grain yield from such a simple and low-cost technology. Confirmation of the effect is required in subsequent years, when the weather pattern will inevitably differ. The present season was characterized by an initial fully charged soil profile, with no replenishment from winter rain. It would be of interest to determine priming effects when there would be less surface soil moisture initially and when winter rains make a significant contribution to crop growth.

The effect of seed priming on grain yield and its components appears to have its origins in the better and faster seedling establishment, perhaps finally allowing some escape of terminal drought and heat stress, and of pod borer damage to some extent. The positive effects of seed priming on disease control and nodulation are intriguing and deserve more in-depth study to understand the mechanisms involved. Soil-borne diseases are likely to assume greater importance as chickpea cultivation in the Barind increases and knowledge of mechanisms to alleviate them would be valuable.

Possible synergistic effects of seed priming with other easily applied seed treatments need to be examined. Such treatments would include fungicide application for soil-borne disease control, *Rhizobium* inoculation to enhance low populations of native rhizobia, and lime/ phosphate/trace element pelleting to alleviate effects of the acid surface soil and nutrient deficiencies.

Notwithstanding further studies on mechanisms of priming effects and possible synergies with other seed treatments, after one more year of confirmation of the priming effect it should be possible to recommend and demonstrate the effect on a large scale in the Barind region, and perhaps elsewhere on difficult post-rice soils in Bangladesh and adjacent areas of India. The effect of priming on other post-rice crops besides chickpea also needs to be ascertained.

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Comparison of Yield and Economics of Irrigated Chickpea Under Improved and Local Management Practices

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Chickpea is the main postrainy-season crop of the Bundelkhand agroclimatic zone in Madhya Pradesh, India covering 28% of the total cultivated area (132 400 ha). Traditionally, chickpea is grown as a rainfed crop under monocropping systems. In recent years, it has been introduced into multiple-cropping systems under limited irrigation. The area and production of chickpea under limited irrigation is gradually increasing. However, the productivity of chickpea continues to be low (1.3 t ha^{-1}). Of the several reasons for low productivity, a major one is nonadoption of improved technology, i.e., suitable varieties, recommended balanced fertilizer use, control of pod borer, and irrigation. The results of several field experiments at the Zonal Agricultural Research Station, Tikamgarh have clearly shown that with improved management the grain yield of chickpea is 3.0-3.5 t ha^{-1}. There is obviously large gap between the yield (1.3 t ha^{-1}) in farmers' fields and the productivity at the research station. Therefore, we decided to demonstrate the available improved chickpea technology to farmers in the Bundelkhand Zone of Madhya Pradesh.

Field demonstrations were conducted under a front-line demonstration program of the Indian Council of Agricultural Research (ICAR) during 1990/91, 1992/93, 1995/96, 1996/97, and 1997/98. A total of 124 field demonstrations were conducted on farmers' fields in Tikamgarh district of Madhya Pradesh in sandy loam to clayey soils. The plot size ranged between 0.4 to 2.0 ha^{-1}. Local practices include sowing seed by the broadcast method, use of the local variety, and the application of 50 kg ha^{-1} diammonium phosphate (DAP) alone as a basal. The recommended package of practices in demonstration plots is described below. The chickpea variety, JG 315 was sown in rows 30 cm apart with a seed rate of 75 kg ha^{-1}. The seeds were treated with thiram at the rate of 3 g kg^{-1} seed and *Rhizobium* culture at 10 g kg^{-1} seed. The