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# Effects of cropping sequence and weed management on density and vertical distribution of weed seeds in alluvial soil

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An important part of crop weed ecology is the weed seed bank as it is the most important source of annual weeds in cropping systems are establishing each year from seeds and therefore represents a significant point in the weed life cycle for control. Because of such germination-delaying factors as the dormancy-non dormancy continuum, seeds of annual species can persist in soil for years, resulting in a reservoir of viable seeds of various ages from which future generations develop (Albrechta and Auerswald, 2009). Understanding the dynamics of weed seed banks is an essential first step in improving weed management plans. By understanding how long seeds remain viable in the seed bank and how those seeds are related to the aboveground weed community, a producer could tailor weed management programs to increase efficiency and efficacy. A package of practice of crop cultivation is to manage weeds toward lowering their total numbers and the numbers of seeds deposited in the soil seed bank (Lamour and Lambertus, 2007). Management practices also alter distribution of weed seeds vertically within the soil profile (Buhler, 1995), which can affect loss of seeds from the seed bank by influencing seed germination, decay, and herbivory. Weed management practices such as hand weeding, mechanical weeding (wheel hoeing), herbicides use and inter row cultivation influencing weed seed density and distribution in the crop field.

The field experiment was conducted in humid sub-tropics of West Bengal at the Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, during *Pre-kharif*, *Kharif* and *Rabi* season, 2011 – 12. The experimental site is situated at 22.93°N latitude, 88.53°E longitude and at an altitude of 9.75 m above the mean sea level. The experiment was laid out in RBD with 5 treatments and 4 replications in the cropping sequence, Blackgram – Brinjal – Mustard. The treatments were as follows- T1: Control, T2: Twice hand weeding at 20 and 40 DAS/DAP, T3: Wheel hoeing at 20 and 40 DAS/DAP, T4: Pendimethalin 30 EC @ 750 g $ha^{-1}$ at 1 DAS + Hand Weeding at 40 DAS, T5: *Parthenium* + *Calotropis* aqueous extract @ 5 % + Hand Weeding at 20 DAS. Each plot was subjected to the same management regime throughout the year course of the experiments. Fertilizer was applied based on University recommendations, with the same rates applied to all treatments within an experiment. Crops were harvested at maturity. All data were subjected to analysis of variance. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez, 1984).

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To determine seed bank composition, soil was sampled within one month after crop planting. Sampling sites were randomly located within rows. Three cores were collected from each plot at one time sampling. Soil cores (3.5 cm diam.) were divided into 0 – 5 cm, 5 – 10 cm and 10 – 15 cm depths and stored in polyethylene bags at 0°C to prevent germination of seeds before extraction. Air-dry soil was sieved through a 2 mm screen to break up clods and remove large particles of plant residue before seeds were extracted. Entire samples collected during 2011 to 2012, which weighed on average 100 g, were extracted individually using the flotation method. After extraction, seeds were air-dried for 12 h and then placed in envelopes. Later, viable seeds were counted by species with the aid of a dissecting microscope. Seed counts were expressed as numbers of seeds by group of species (monocot and dicot) per mass of soil.

Weed pressure became excessive in plots without any treatments. More than 90 % of the weed seeds in the seed banks of experiment were small seeded annual weeds, especially *Echinochloa colona*, *Dactyloctaneum aegyptium*, *Digitaria sanguinalis*, *Eleusine indica*, *Digera arvense*, *Phyllanthus niruri*, *Physalia minima*, *Euphorbia hirta*, *Amaranthus viridis*, *Chenopodium album*, *Argemone mexicana* etc but numbers were so low that treatment differences could not be detected and therefore are not reported.

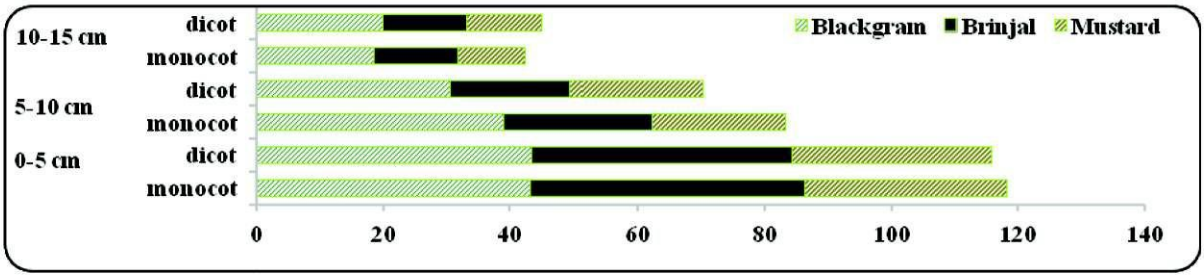


**Fig. 1: Effect of no treatment on vertical distribution of weed seeds.**

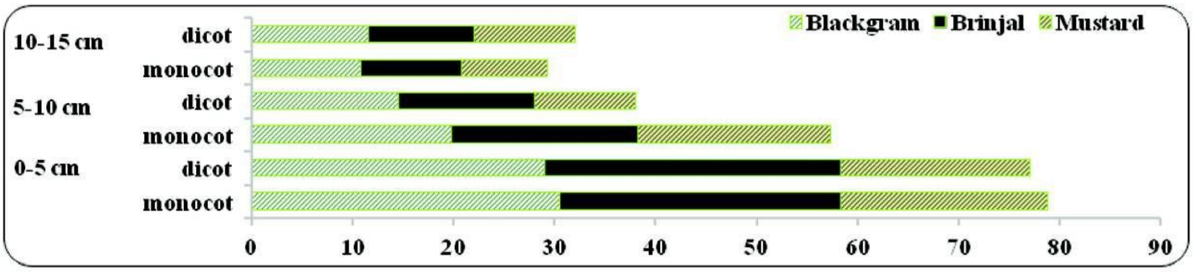


**Fig. 2: Effect of hand weeding on vertical distribution of weed seeds.**

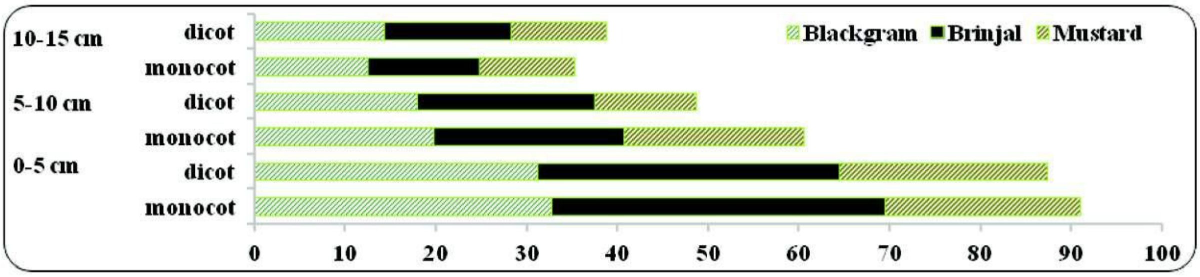


**Fig. 3: Effect of mechanical weeding on vertical distribution of weed seeds.**

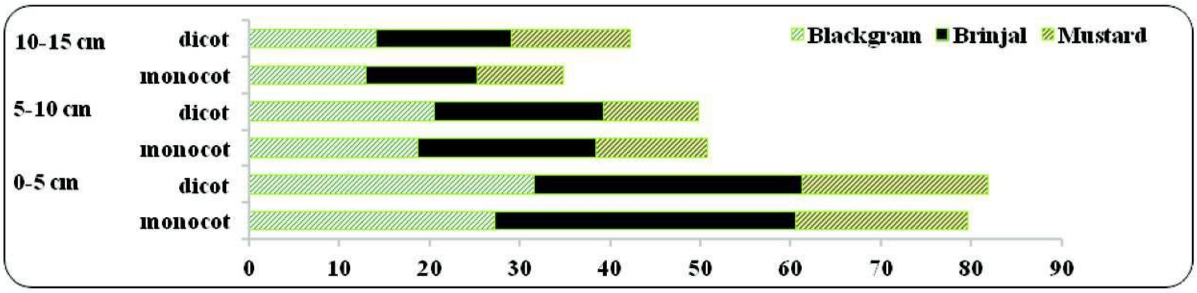


**Fig. 4: Effect of herbicide on vertical distribution of weed seeds.**

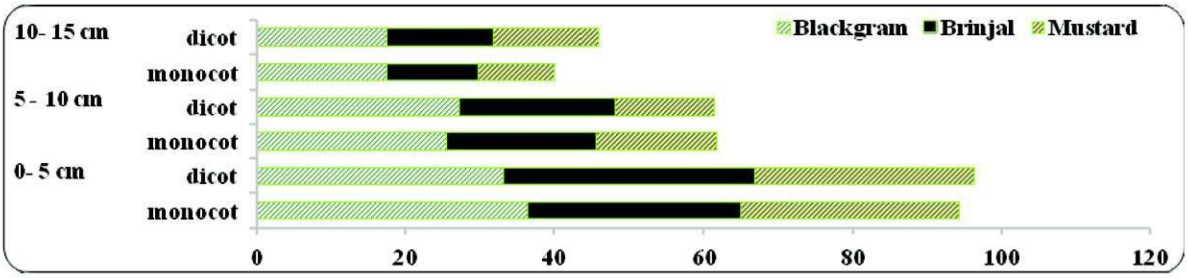


**Fig. 5: Effect of botanical herbicide on vertical distribution of weed seeds.**

Weed seed numbers differed among sampling depths. Such differences were expected, considering the type of weed management practices used prior to establishing each study (Ball, 1992). Numbers of weed seeds decreased with depth in the blackgram, brinjal, mustard cropping sequence. The largest numbers of weed seeds in the study were found at the 0 – 5 cm depth (Fig. l to 5), which is a characteristic of vertical distribution of soil seed bank (Mohler *et al*., 2006). Data from blackgram are used to show the differences and changes in seed numbers both monocot and dicot relative to mustard, when treatments began. In blackgram, differences in weed seed distribution among sampling depths resulted from using hand weeding prior to initiation of the experiment (Fig. 2). Monocots, which comprised about more than 50 % of the total seed bank, were the weed type most affected by treatments over the consecutive three seasons of the experiment. Both vertical distribution and relative abundance of weed seeds changed in hand weeding plots after the end of the cropping sequence. Almost similar observation was recorded in mechanical weeding plots throughout the sequence (Fig. 3). But due to conversion of soil by wheel hoe, certain amounts of seeds were distributed in the deeper layer of soil which ultimately reduces the number of weed seeds in top layer. But in brinjal crop season both type of weed seeds (monocot and dicot) were maximum in 0 – 15 cm soil depth due to early flushes of rain, more luxuriant growth of weed plants and shading of seeds, resulting concentrated weed seed bank. The suspected explanation underlying this relationship is that small and compact seeds are more easily buried by rain, animals or gravity (Peart, 1984). Whereas, the plots with no treatment concentrated weed seeds in the top 5 cm of soil (Fig. 1). Relative abundance of weed seeds doubled in the surface layer of control plots, but was reduced by half in the 10 – 15 cm layer. It is common to find vertical movement of weed seeds due to tillage at the time of land preparation (Clements *et al*., 1996). Crop rotation and herbicide rate significantly affected the weed seed bank (Fig. 4). This can be explained by a greater efficacy of continuous use of Pendimethalin to reduce the monocotyledonous and dicotyledonous seed bank. Similar trend of observation was recorded in botanical herbicide treated plot (Fig. 5) also. Treatment effects on numbers of weed seeds were more repetitive in the blackgram – brinjal – mustard cropping sequence than the mono crop experiment (Rouane, 2009).

Crop rotation is known to modify seed banks, especially their composition (Cardina *et al*., 2002). However, the effect of the crop rotation itself generally is not separated from that of weed management practices. Our results suggest that the seed bank of the monocotyledonous and dicotyledonous weed type in treated plots or in plots that received herbicide was reduced at the end of crop sequence. Sosnoskie *et al.* (2006) observed similar findings of total seed banks in corn/soybean rotations than in corn monocultures after 35 yr. This could be related to lower seed production of the residual weeds (plants not killed by the herbicide or that germinate after herbicide action) which allows seedlings to emerge and be killed by hand weeding and/or herbicide application in the next crop season. The findings were not out of new in that similar findings have been reported by Rouane (2009) and Simard *et al*. (2011). Hoffman *et al*. (1998) reported that seed density and distribution in the top 5 cm of soil were of the greatest consequence in these studies, which were dominated by small seeded weeds that lack energy reserves to allow emergence from deep below the soil surface. Although tillage affected vertical distribution of seeds, herbicides and crop cultivation that regulate weed seed production had more influence on seed distribution in the 0 to 5 cm layer of soil. Thus from the observation it revealed that weed seed bank was influenced by any types of management (physical, mechanical, chemical & biological). All the weed management treatments reduced the weed seed bank as compared to the control by 32.38 % (physical), 30.67 % (chemical), 23.87 % (mechanical) & 15.95 % (biological) at the end of the cropping sequence.

We conclude that weed control practices and cropping sequence can prevent increased numbers of weed seeds in soil profile and can maintain an annual plan for proper cost effective weed management practice.

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