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STUDIES ON WEED SEED DYNAMICS IN SOIL SEED BANK OF RICE-BASED CROPPING SYSTEM OF PAKISTAN

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ABSTRACT

A seed is a bridge between two generations. Failure of the seeds to germinate even if required conditions for germination viz. water, oxygen, and light, are available, is called dormancy. The differential weed seed dormancy has been speculated to be the causes of heavy weed infestations in the rice based cropping system. The investigations were started with the collection of soil samples from the rice growing areas of Dera Ismail Khan, NWFP and Sheikhupura, Punjab during the month of late April and early May, 2002 to test the weed dynamics in the soil seed bank The soil samples were tested in the pots for their germination pattern and the size of the seed bank. The soil seed bank varied over different locations and depths (0-10, 10-20 and 20-30 cm soil depth). The highest activity of both grasses and broadleafs was recorded in 0-10 cm soil layers. The grasses predominated the seed bank in D.I.Khan, while there was a preponderance of broadleafs in the rice-based area of Punjab. Further investigations are recommended to understand the magnitude of seed bank and its manipulation

INTRODUCTION

The rice-wheat belt is the home to more than 600 million people in South Asia. Farmers grow rice in the monsoon (kharif) season followed by wheat in winter (rabi) season. Farmers use this system on nearly 12 million ha in South Asia along large areas of Pakistan, Northern India, Nepal and Bangladesh. China has an additional 10 million ha of rice-wheat area. In Pakistan, the area under rice is 2.4 million ha, and nearly 62 per cent of which is in Punjab. On major part of this rice hectarage, rice-wheat system is followed. The average yield of fine rice (Basmati) is about 89 per cent lower than the coarse varieties (IRRI) but the farmers, especially in Punjab prefer to grow fine rice .The declining trend in crop yields under this system not only needs to be arrested but also reversed. It is very astonishing that despite the maintenance of flood to a level of more than 4 inches throughout the rice-growing season, the annual weeds subsequently infest the succeeding crops like wheat and gram in higher intensity, although with an altered composition. A seed represents the end of flowering process and the beginning of a new generation. It contains the new plant in miniature, means for dispersal, survival, renewal and germination. Failure of the seeds to germinate even if required conditions for germination viz. water, oxygen, and light, are available, renders them dormant. The most

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prominent attribute of seeds which confers success to weeds is dormancy or rest period, which enables the seeds to persist in the soil and survive under the conditions not suitable for plant growth (Karssen, 1982: Harper, 1977; Holt, 1987). The factors responsible for dormancy are either innate or environmental (Radosevich and Holt, 1984). Harper (1957; 1977) suggests that some seeds are born dormant (innate), some achieve dormancy (induced) and some have dormancy thrust upon them (enforced or quiescence). The density of the seeds in soil varies from 0 (in newly cultivated soil) to as high as 137,700 seed m^{-2} (Wilson, 1987). The number of seeds in upper 15-25 cm of soil in cultivated fields is as high as 70,000 to 90,000 m^{-2} (Kropac, 1966; Roberts, 1981). Sahoo et al. (1995) counted 3-4 times more seeds in conventional vs. no tillage. The other studies show the seed viability from 39 to 100 years (Toole and Brown, 1946; Livingston and Allesio, 1968; Oosting and Humphreys, 1940). Hence, Kremer (1995) has the opinion that successful weed management in agro-ecosystem centers around the manipulation of weed seed bank in the soil. Wesson and Wareing (1969) reported that burying induced the seeds of several species to need light. Popay and Roberts (1970) and Benvenuti and Macchia (1995) claimed that the high CO_2 and low O_2 (hypoxia) induced dormancy while Taylorson (1980) reported otherwise. Several studies exhibit that the buried seeds of annual weeds undergo dormancy-non-dormancy cycles and even light does not stimulate germination (Karssen, 1970; Schafer and Chilcote, 1970; Taylorson, 1970). Baskin and Baskin (1985) and Benvenuti and Macchia (1994) have further added that dormancy-non-dormancy transition may be related to changes in membrane properties. Carmona and Murdoch (1996) deciphered the differential response of temperature on *Chenopodium album*, *Rumex crispus*h and *Avena fatua* seeds. Charles (1996) found a varying seed dormancy among the several species investigated. Caudra et al. (1996) reported increased germination in GA_3 incubated seeds.

In rice based farms in District D.I.Khan are infested with meadow peavine *(Lathyrus aphaca)*, grass peavine *(L. sativus)* and common vetch *(Vicia sativa)* besides canarygrass [personal observation]. Keeping in view the importance of the differential dynamics of weeds in the rice based cropping system; an experiment was carried out with the objective to study the dynamics of weed seeds in seed bank of different ecological zones in the rice based cropping system at different soil depths.

MATERIALS AND METHODS

Soil samples were collected from the rice-based cropping system soils of Dera Ismail Khan and Sheikhupura, from an area of 30 cm x 30 cm to a separate depth of 0-10, 10-20 and 20-30 cm from the previously planted wheat fields right before planting rice. The samples were labeled and stored in separate packets for each depth. The germination pattern in the soil was deciphered by filling the soil in 15 cm dia. and 12 cm deep plastic pots. Each treatment comprised of a single pot. First run of the experiment was raised from September 20, 2002 to the third week of October 2002. The second run was investigated from November 11, 2002 to the third week of December, 2002. The pots were watered equally as per need. The germination data were recorded on grasses and broadleaf species. At that stage however the identification of various grass and broadleaf species was not possible to the desired accuracy, hence only the grouping in the major categories is reported. The data subjected to ANOVA by taking the runs as replications. The other variables were locations and depth from which soil was collected. These data were subjected to ANOVA and the significant means were separated by the least significant difference test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The ANOVA exhibits that for grasses the significant differences existed for locations and soil depths, whereas the interaction of locations and runs were statistically non-significant. The results thus, exhibit that the behavior of seeds from different locations was similar. Similarly, the ANOVA for broadleaf weed exhibit statistical significance only for the soil depths; all other parameters are non-significant statistically for the broadleafs.

The perusal of data in Table-1 reveals the varying population of grasses across the locations. The highest population of grasses (4.667/pot) was recorded at Ghebbi, D.I.Khan. However, it was statistically at par with all the locations in D.I.Khan and sites V and VI at the Rice Research Institute, Kala Shah Kaku. Generally, all the sites in the rice based cropping system of Punjab, show a lower population of grass species, whereas the emergence of grasses although higher in D.I.Khan soils, it was stable across the locations indicating a similar potential of infestation of grasses throughout the area under reference (Table-1). The least population (0.00) was recorded at Rice Research Institute site II. For the emergence of grasses across the soil depths, the highest (3.3/pot) was recorded from 0-10 cm depth, which however was statistically comparable with the 10-20 cm soil depth (2.1/pot). The least population of grasses was deciphered in the 20-30 cm soil depth (1.1/pot) [Table-1].

For the broadleafs, the trend was reverse as far as D.I.Khan and Rice Research Institute is considered. The density of broadlefs was generally higher in the Punjab as compared to NWFP. Although, non-significant statistically, the highest density (9) was recorded at Rice Research Institute site II, where no grass seedling emerged (Table-2). The next higher population (6) of broadleafs was recorded at Chah Malwana, D.I.Khan. For the soil depths, the highest population of broadleafs (7.2) was recorded at 0-10 cm depth (Table-2), like the pattern observed for grasses 9table-1). It was however, statistically comparable with population of broadleafs emerged from 10-20 cm depth (3.55). Minimal seeds of broadleafs germinated from the 20-30 depths (Table-2). For the interaction, though non significant statistically, the highest population of grasses and broadleaf's was recorded at Chah Malwana, D.I.Khan and RRI, site II at 0-10 cm and 10-20 cm respectively (Tables-1 &2). All the interactions involving 0-10 cm depth contained more germinated seeds as compared to the other two depths. The interactions involving 20-30 cm depth germinated fewer seeds (Tables-1&2). These findings are in a partial agreement with the work reported by Wilson, 1987; Kropac, 1966 and Roberts, 1981 who found density of the seeds in soil varying from 0 (in newly cultivated soil) to as high as 137,700 seed m^{-2}. Sahoo et al. (1995) counted 3-4 times more seeds in conventional vs. no tillage. Our findings also conglomerate the observations of Kremer (1995) who communicated that successful weed management in agro-ecosystem centers around the manipulation of weed seed bank in the soil.

Table-1: Location x soil depth effect on grassy weed seed germination per pot

Locations	Soil depths			
	0-10 cm	10-20 cm	20-30 cm	Location Means
Ghebbi, D.I.Khan	2.5	8.5	3.0	4.667a
Thatta Baluchan, D.I.Khan	5.5	3.5	4.0	4.333a
Chah Malwana, D.I.Khan	8.5	2.5	1.0	4a
Kot Jai, D.I.Khan	7.0	2.5	2.5	4a
RRI† site I	0.5	0.0	0.0	0.167b
RRI site II	0.0	0.0	0.0	0b
RRI site III	0.0	1.0	0.0	0.333b
RRI site IV	0.0	1.5	0.0	0.5b
RRI site V	4.0	0.5	0.0	1.5ab
RRI site VI	5.0	1.0	0.5	2.167ab
Depth Means	3.3a	2.1ab	1.1b	-
$LSD_{0.05}$ for Locations	3.306 per pot			
$LSd_{0.05}$ for depths	1.811 per pot			

† RRI is Rice Research Institute, Kala Shah Kaku, Lahore

Table-2: Location x soil depth effect on Broad Leaf weed seed germination per pot

Location	Soil depths			
	0-10 cm	10-20 cm	20-30 cm	Location Means
Ghebbi, D.I.Khan	5.50	1.00	1.00	2.500
Thatta Baluchan, D.I.Khan	5.0	3.0	3.0	3.667
Chah Malwana, D.I.Khan	9.0	7.5	1.5	6.000
Kot Jai, D.I.Khan	3.5	3.5	1.0	2.667
RRI† site I	2.0	0.5	0.5	1.000
RRI site II	12.5	16.0	0.5	9.667
RRI site III	12.5	0.0	0.0	4.167
RRI site IV	13.0	0.5	0.0	4.500
RRI site V	1.0	1.0	0.5	0.833
RRI site VI	8.0	2.5	1.0	3.833
Depth Means	7.2a	3.55ab	0.9b	-
$LSd_{0.05}$ for depths	4.79/pot			

† RRI is Rice Research Institute, Kala Shah Kaku, Lahore

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