Pak. J. Weed Sci. Res. 10(3-4):185-192, 2004

DORMANCY STUDIES IN SOME MAJOR WEED SEEDS OF RICE BASED CROPPING SYSTEM OF PAKISTAN

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ABSTRACT

Rice-based cropping system is contributing significantly to the overall agricultural production of the country. The declining trend in the production under the rice-based agriculture has alarmed the scientists and policy makers alike to arrest rather reverse the trend. The heavy weed infestations in the rice based cropping system are one of the causes of decline. Differential dormancy is the probable cause of the peculiar weed flora in the rice based cropping system. The investigations were initiated with the collection of seeds of the prevailing major weeds of wheat viz. field bindweed (Convolvulus arvensis), wild oats (Avena fatua), little seed canary grass (Phalaris minor), meadow peavine (Lathyrus aphaca), curly dock (Rumex crispus) and fumitory (Fumaria polymorpha) from the wheat fields in rice growing areas of Dera Ismail Khan, Faisalabad and Sheikhupura during the month of late April and early May, 2002. The seeds were tested for their germination pattern under laboratory conditions. The germination pattern is quite different in different weed species. A single seed of curly dock (Rumex crispus) could not be germinated in any of the several runs of lab. experiments. The germination of some species was favored by the comparatively higher temperatures like field bindweed while. the germination in some other species like wild oats was favored by lower temperature.

Key words: Dormancy *Convolvulus arvensis Avena fatua Lathyrus aphaca* germination

INTRODUCTION

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. Rice (*Oryza sativa* L.) is the staple food in Pakistan grown on 10.5% area, with an average production of 5.156 million tons with a mean yield of 2.056 t ha^{-1} (Anonymous, 2000). In Pakistan, rice follows wheat as a staple diet. Rice based cropping system is playing a pivotal role in terms of agro-based export and feeding the nation. The declining trend in crop yields under this system not only needs to be arrested but also reversed, in the best interest of the nation. 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 diversity. There are several features, which have rendered the weed species successful, but the most important one is the seed 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). Numerous

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investigations spread over many years have studied basic and practical aspects of the problem (Crocker and Barton, 1953). 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). Popay and Roberts (1970) and Benvenuti and Macchia (1995) showed that the high CO_2 and low O_2 (hypoxia) induced dormancy while Taylorson (1980) reported otherwise. The studies of Holm (1972) showed that as decreased O_2 in the soil microenvironment accumulated acetaldehyde, ethanol and acetone. 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 ad 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 crispush* 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. The study of (Plyler and Carrick, 1993) revealed that dormancy could be broken surgically by altering the scutellum or chemically by applying fusicoccin.

It has been observed in Indo-Pak sub-continent that littleseed canary grass *(Phalaris minor)* has seriously infested the rice-based cropping system. Moreover, in rice based farms in District D.I.Khan are also infested with meadow peavine *(Lathyrus aphaca)* and common vetch (Vicia sativa) [personal observation]. We postulate that heavy infestation of these weeds in the rice based cropping system are due to the differential response of these species to the cultural package adopted in rice viz. puddling and flooding. Keeping in view the importance of the differential dynamics of weeds in the rice based cropping system; experiments were carried out under laboratory conditions with these objectives a) to provide information about the occurrence of dormancy b) to figure out the dormancy patterns of some weed species of rice involving cropping system and c) to investigate the behavior of dormancy related to different geographical locations of rice based cropping system.

MATERIALS AND METHODS

The seeds of different weed species viz. wild oats (*Avena fatua* L.), little seed canary grass (*P. minor* Retz.), meadow peavine (*L. aphaca* L.), field bindweed *(C. arvensis* L.*)*, curly dock (*R. crispus* L.), and fumitory (*F. indica* L.) collected from the 2001-2 wheat crop from Dera Ismail Khan, Sheikhupura and Faisalabad were planted in petri dishes under the ambient conditions to observe their germination pattern. The first experiment was run from October 17 to November 13, 2002. The second, third and fourth experiments were conducted from November 8 to December 5, November 15 to December 12 and January 6, 2002 to February 3, 2003, respectively. Except for the first experiment a constant number of 15 seeds of all the species were planted/petri dish. There were two repeats per treatment in all the experiments. Data were recorded on germinated seeds on daily basis and later on the cumulative data of days on weekly basis was compiled for statistical analyses. The data were subjected to the analysis of variance technique by taking the variables locations, species and time of germination in completely randomized design as outlined by Steel and Torrie (1980). The significant means in category were separately subjected to the LSD test for separation of gaps among means.

RESULTS AND DISCUSSION

The analysis of variance depicted statistically significant ($P<0.05$) differences for species, species x locations, locations x time of germination and location x species x time interactions. The perusal of data in Table-1 exhibits that highest germination and consequently the lowest dormancy was recorded in *P. minor* seed collected from Faisalabad. Seed source i.e location inflicted a conspicuous effect on dormancy. Lower germination in *A. fatua* revealed its thermo-sensitive behavior under the ambient environmental conditions. Similarly, *L. aphaca* also possessed poor germination (Table-1). The data in Table-2 manifested a range of differences in the numerical values, yet the differences could not attain the statistical significance showing the trend of germination over time was similar among all the species contemplated. However, variability existed for the main effects of time of germination (Table-2). The maximum mean germination (8.474%) was recorded during the third week of experimentation; however, it was statistically at par with the remaining weeks except the second week (Table-2). The 3-way interaction (Table-3) showed the highest germination in the *P. minor* from D.I.Khan the first week of experiment. The lowest germination or the highest dormancy was recorded in *A. fatua* from either location. Germination patterns of seeds from different locations were variable. *P. minor* having the highest germinability behaved differentially from either site of collection as far as the timing of germination is concerned (Table-3).

The analyses of data across the runs, species and time of germination for D.I.Khan revealed statistically significant differences for runs, times and runs by species into times (Table-4). Generally the germination was higher in the second run of the experiment across all the species. The highest germination percentage (24.999) or the lowest dormancy was reflected in *L. aphaca*. Similarly, there was a clear-cut difference in the first (4.951) and the second run (17.222) of experiments (Table-4). Among the species the highest mean weekly germination (15.999) was recorded for the main effects of *L. aphaca*, while *A. fatua* possessed the least germinability (7.083) [Table-4]. The behavior of species over time is enunciated in Table-5. The germination was generally higher among the species during the first week of the experiments (Table-5). The highest germination (32.165) and consequently the lowest dormancy were visible in *L. aphaca*. The least germination (0 %) was recorded in *A. fatua* during the Third week of experimentation. The main weekly effects also show the superiority of germination during the first week (20.243), while the least germination (9.293) was recorded during the third week of studies (Table-5). The reference of data in Table-6 exhibits the highest germination (63.33) in *L. aphaca* during the first week of the second run. It was followed by *P. minor* and *A. fatua* (30.00 each) during the fourth and second week, respectively. The least germination (0.00) was contemplated in *A. fatua* in the first run of the trial, where during all four weeks, the seed of the referred weed was altogether dormant (Table-6) exhibiting the inhibitory response of higher temperature in the referred species.

ACKNOWLEDGEMENTS

The funding for this research was allocated by the Agricultural Linkages Program, Pakistan Agricultural Research Council, Islamabad, which is very gratefully acknowledged.

Table-1. Mean weekly germination (%) data of different species seed collected from rice-based cropping system of D.I.Khan and Faisalabad

Species	D.I.Khan	Faisalabad	Species Means
Avena fatua (wild oats)	0 c	4.168bc	*2.084*
Phalaris minor (canary grass)	7.853b	13.92a	10.886
Lathyrus aphaca (meadow peavine)	7.000b	*2.75bc*	4.875
Location Means	4.951	6.951	-

Table-2. Mean weekly germination (%) over time data of different species seed collected from rice-based cropping system of D.I.Khan and Faisalabad

Species	24.10 to 30.10.2002	1.11 to 6.11.2002	7.11 to 13.11.2002	14.11 to 20.11.2002	Species Means
Avena fatua (wild oats)	0	0	5.000	3.335	2.084
Phalaris minor (canary grass)	14.28	4.99	16.423	7.853	10.886
Lathyrus aphaca (meadow peavine)	3.500	4.500	4.000	7.500	4.875
Time Means	5.927ab	3.163b	8.474a	6.229ab	-

Table-3. Mean weekly germination (%) over location x species x time of different species seed collected from rice-based cropping system of D.I.Khan and Faisalabad

Species	Location	24.10 to 30.10.2002	1.11 to 6.11.2002	7.11 to 13.11.2002	14.11 to 20.11.2002
Avena fatua (wild oats)	Faisal Abad	0c[2]	0c	10.000bc	6.670bc
Phalaris minor (canary grass)	Faisalabad	1.425c	8.555bc	31.420a	14.280b
Lathyrus aphaca (meadow peavine)	Faisalabad	6.000bc	0.000c	1.000c	4.000bc
Avena fatua (wild oats)	D.I.Khan	0.000c	0.000c	0.000c	0.000c
Phalaris minor (canary grass)	D.I.Khan	27.135a	1.425c	1.425c	1.425c
Lathyrus aphaca (meadow peavine)	D.I.Khan	1.000c	9.000bc	7.000bc	11.000bc

Table-4. Mean weekly germination (%) data of different weed species and runs of experiments

Species	24.10 - 20.11.2002	8.11 - 5.12.2002	Species Means
Avena fatua (wild oats)	0	14.166	7.083
Phalaris minor (canary grass)	7.853	12.500	10.176
Lathyrus aphaca meadow peavine)	7.000	24.999	15.999
Location Means	4.951	17.222	-

Table-5. Mean weekly germination (%) over time data of different species seed collected from D.I.Khan and Faisalabad

Species	First Week	Second Week	Third Week	Fourth Week	Species Means
Avena fatua (wild oats)	11.665	15.000	0.000	1.668	7.083
Phalaris minor (canary grass)	16.900	0.712	7.380	15.714	10.176
Lathyrus aphaca (meadow peavine)	32.165	17.832	3.500	10.500	15.999
Time Means	20.243	11.182	3.627	9.293	-

Table-6. Mean weekly germination (%) over runs x species x time of different species of weeds of the rice-based cropping system

Species	Runs	First Week	Second Week	Third Week	Fourth Week
Avena fatua (wild oats)	24.10 - 20.11.2002	0.000	0.000	0.000	0.000
Phalaris minor (canary grass)	10.11 - 20.11.2002	27.135	1.425	1.425	1.425
Lathyrus aphaca (meadow peavine)	24.10 - 20.11.2002	1.000	9.000	7.000	11.000
Avena fatua (wild oats)	8.11 – 5.12.2002	23.330	30.000	0.000	3.335
Phalaris minor (canary grass)	8.11 -5.12.2002	6.665	0.000	13.335	30.000
Lathyrus aphaca (meadow peavine)	8.11 – 5.12.2002	63.330	26.665	0.000	10.000

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