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IMPACT OF SOIL MOISTURE AND SOIL DEPTHS ON RESPROUTING ABILITY OF JOHNSON GRASS (*Sorghum halepense* L.) RHIZOMES

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ABSTRACT

An experiment was conducted in the department of Weed Science during September-December 2013, to study the effect of different levels of soil moisture and soil depths on the resprouting ability of Sorghum halepense L. rhizome fragmentations. The experiment was carried out in pots filled with a mixture of sand, silt and clay. Fresh rhizomes were collected from New Developmental Research Farm, The University of Agriculture Peshawar, cut into pieces each having 3-4 buds/eyes or about the pieces that usually a rotavator cuts during seed bed preparation for the next crop. These pieces were buried in pots (with a diameter 10 inches) into various depths i.e 2, 4 and 6 inches from soil surface. The pots were irrigated with low, medium and high levels of irrigation according to the mentioned plan of work. The basic experiment was replicated three times. Data were collected on days to sprouting, number of sprouts pot^{-1}, plant height (cm), rhizome weight (g) and number of other weed species. The analysis of the data showed that different moisture level had no significant effect on the resprouting of rhizomes and plant height of Sorghum halepense L. However, various soil depths had a significant effect on the resprouting ability of rhizome and plant developed from that rhizome. Maximum sprouting pot^{-1} occurred in 6 inches depth as compared to 2 (0.55) and 4 inches depths (0.66). Days to sprouting in various treatments were different and were less affected by both factors (soil depth and moisture levels). Plant height was significantly affected by various soil depths but different soil moisture did not affect the plant height. Maximum plant height was noted in 6 inches soil depth (31.22 cm) as compared to 4 inches soil depth (8.44 cm), however it was statistically at par with the 2 inches soil depth (13.27 cm). Similarly rhizome weight and germination of other weeds species were neither affected significantly by various moisture levels nor soil depths. The number of broad leaf weeds was significantly

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affected by soil depth and various moisture levels as compared to grassy weeds. Maximum broad leaf weeds germinated in optimum soil moisture level (1.55) as compared to low (0.88) and high moisture level (1.33). Similarly maximum broad leaf weeds occurred in 2 inches soil depth (1.77) as compared to 4 (0.88) and 6 inches soil depth (1.11). Ten different weed species were recorded from the pots during the experiment. Among them Poa annua, L. Digitaria sangunalis L. Eragrostis sp. Leptochloa were the grassy while Oxallis corniculata L. Portulaca oleracea. L. Trianthema portulacastrum L. Euphorbia hirta L. Medicago denticulata and Ammi visnaga L. were broad leaf weeds.

Keywords: *Sorghum halepense* L., rhizomes, soil moisture, soil depths, resprouting ability.

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INTRODUCTION

Sorghum halepense L. commonly known as Johnson grass belong to poaceae. It is perennial and reaches up to 3 m height with a inflorescence up to 50 cm long. It is among the ten worst weeds of the world (Holm *et al.,* 1977). It grows in the spring often from the over-wintered rhizomes with a very rapid early start by using the stored carbohydrates (Holm *et al.,* 1977). The secondary tillers sprout within a month, approximately after the plant attains six leaves. The plant reaches to the flowering within two months in favorable climatic conditions and flowering continues right through the growing season. Almost all of the rhizomatic growth occurs after flowering (Warwick and Black 1983), however, no causal relationship exists between the two (Horowitz, 1972; Monaghan, 1979).

Sorghum halepense L. is a noxious weed, with a global distribution, adapted to a wide range of habitats including open lands, forests, cropping systems, ditches banks and wetland conditions. It is an aggressive weed, forming crowded colonies and often chocks the growth of less aggressive native vegetation and tree saplings. Although *S. halepense* is found worldwide now, it is conceived to be native to the Mediterranean region (Alex, 1970). It is a major problem in more than fifty countries, ranging in latitude from 55 N to 45 S; the weed is more aggressive in Mediterranean to the Western Asia and India, Australia, South America and the Gulf of Mexico (Holm *et al*., 1977). Due to its invasive nature Johnson grass attacks often disturbed lands, ditch banks, cropping systems and wastelands, and flourishes well below 5,000 feet elevation in irrigated plains of Arizona (Gould, 1951). The prolific seed production, extensive rhizome system, sprouting ability of fragmented rhizomes and ability to grow in a wide range of environments makes its management a cumbersome task for the weed managers. Rhizome fragments in moving water for eight days, or in stagnant water for four weeks had no effect on their resprouting ability (Horowitz, 1972)while the seeds can remain viable in soil for periods of up to 6 years (Leguizamon, 1986).

Sorghum halepense prefers moderately acidic (pH 5-7.5) and clay soils with higher water-holding capacity and thrives well in moist habitats (Newman, 1993; Ball *et al*., 2007). However, it is also drought tolerant, which makes it to tolerate the dry summer seasons. It cannot tolerate cold months; however, some cold-tolerant ecotypes have been found in the Northern parts of US and South of Canada (Warwick and Black, 1983). Due to such adaptability it is currently found in all states of US except Minnesota and Maine. In addition to its drought tolerance, it is also tolerant to soil salinity. Sinha *et al*. (1986) reported that Johnsongrass can withstand high salinity without many adverse effects as long as adequate water is available. Water and temperature have a profound effect on the resprouting ability of Johnsongrass (Loddo *et al*., 2011). Increasing soil salinity (0.5-10 ds m^{-1} lowered total biomass by 25.3% and increased N, P, K, Ca, and Mg conc. in tissues significantly.

The best time for its management is before six leaf stage when formation of new rhizomes has not yet begun and carbohydrate supply is at its lowest conc. During the fall rhizome carbohydrate levels are again low, due to the formation of over- wintering rhizomes (Horowitz, 1973). Plows break up the rhizomes and bring them to the surface of the soil where they desiccate (McWhorter, 1981). Tillage does not significantly affect Johnsongrass control (Banks and Bundschuh, 1989). However, plowing could spread the rhizomes and increase the problem if contaminated machinery is used in uninfested areas (Cox, 1989). A combination of mowing, tilling, and herbicide applications may provide adequate control of *S. halepense* and may produce better effects than just one technique alone. Once successful control has been reached, a rapid re-vegetation project should be implemented for the establishment of native plants. If transplants are to be used, plants should be grown during the eradication period (Newman, 1989). Keeping in view the importance of tillage in dissemination of *S. halepense* through rhizome fragmentations and the resprouting ability of rhizomes which depends on the depth and moisture levels of the field a pot experiment was conducted with the objectives to study the resprouting of Johnsongrass rhizomes in relation to various soil depths, to investigate the sprouting ability and plant vigor in response to different water regimes, and to know the interaction between various water regimes and soil depth on vigor and resprouting of the plant.

MATERIALS AND METHODS

A pot experiment was conducted during September–December, 2013, in Department of Weed Science, The University of Agriculture Peshawar Khyber Pakhtunkhwa, to investigate the impact of soil moisture and various soil depths on the resprouting ability of Johnson grass (*Sorghum halepense* L.) rhizome fragments. The experiment was conducted in RCB design with split plot arrangement having three replications. The pot size was 10 inches. Each pot was filled with soil (mixture of sand silt and clay). The fresh rhizomes collected from infested fields were cut into pieces each having 3-4 eyes (about the pieces that usually a rotavator cuts). These pieces were buried in pots at depths of 2, 4 and 6 inches from soil surface in the pot.

Three levels (low, moderate and high) of moisture were used to the respective pots. The data were collected on number of sprouting in each pot, days to sprouting, plant height (cm), rhizome weight (g) at the end of experiment and number of other weed species.

RESULTS AND DISCUSSIONS

Number of sprouting

The data regarding number of sprouting of *sorghum halepense* as affected by various moisture level and soil depths presented in Table-1. The analysis of data showed that different soil depth had significantly affected the number of sprouts from rhizome fragments while different level of irrigation and their interaction had no significant effect on the number of sprouts of rhizome. Maximum number of sprouts occurred in the 6 inches depth (3.11) while the minimum number of sprouts occurred in 2 inches depth (0.55) which were statistically at par with 4 inches depth (0.66). These results are in line with the work of Benvenuti *et al*. (2001) who reported that rhizomes of Johnson grass possess the tendency to sprout from maximum soil depth.

Table-1. Number of sprouts of *Sorghum halepense* rhizomes as affected by various moisture levels and soil depths

Soil Depth (inches)	Irrigation			Depth means
	High	Moderate	Low	
2	0.33	0.66	0.66	0.55b
4	0.66	1.33	0.00	0.66 b
6	4.00	2.33	3.00	3.11 a
Irrigation Means	1.66	1.44	1.22	

$LSD_{(0.05)}$ soil depth = 1.1, $LSD_{(0.05)}$ Irrigation = NS, $LSD_{(0.05)}$ interaction= NS

Days to sprouting

Data regarding days to sprouting of *Sorghum halepense* as affected by various moisture levels and soil depth is given Table 2. Analysis of the data showed that effect of soil depth, irrigation regimes and their interaction had non-significant effect on days to sprouting of Johnson grass rhizome fragments. However, maximum days to sprouting (21.77) were noticed in the minimum depth (2 inches) while among the various moisture levels maximum days to sprouting (17.11) were recorded in moderate irrigation regime while the lowest days to sprouting (12.44) were noticed in low irrigation regime. According to Rask and Andreasen (2007), depth and fragmentation delayed emergence time.

Table-2. Days to sprouting of *Sorghum halepense* rhizomes as affected by various moisture levels and soil depths.

Soil Depth (inches)	Irrigation			Depth means
	High	Moderate	Low	
2	14.00	23.33	28.00	21.77
4	14.00	11.66	0.00	8.55
6	18.66	16.33	9.33	14.77
Irrigation Means	15.55	17.11	12.44	

LSD(0.05) for soil depth = NS, for Irrigation=NS, for interaction= NS

Plant Height (cm)

The statistical analysis of the data regarding the plant height of Johnson grass showed that plant height is significantly affected by various soil depths (Table-3). Maximum plant height (31.22 cm) was recorded in 6 inches depth while the lowest plant height (8.44 cm) was noted in 4 inches soil depth. While the irrigation regimes and their interaction with soil depths had non-significant effect on the plant height of Johnson grass. These results are in line with the work of Rask and Andreasen (2007) who reported that Burial at 15 or 25 cm reduced above ground biomass while drying periods of 12-24 hours did not affect production of shoots.

Table-3. Plant height (cm) of *Sorghum halepense* rhizome as affected by various moisture levels and soil depths.

Soil Depth (inches)	Irrigation			Depth means
	High	Moderate	Low	
2	1.66	23.00	15.16	13.27 b
4	5.66	19.66	0.00	8.44 b
6	30.00	31.66	32.00	31.22 a
Irrigation Means	12.44	24.77	15.72	

LSD (0.05) for soil depth =16.67, for Irrigation=NS, for interaction=NS

Rhizome weight (g)

The analysis of data revealed that various moisture levels and soil depths did not affect the final weight of *Sorghum halepense* rhizomes (Table-4). However, among soil depths maximum rhizome weight (3.87) was noted in the 6 inches soil depth while among the irrigation levels maximum rhizome weight was recorded in the moderate irrigation level (3.63). These results are at par with those obtained by Rask and Andreasen (2007) who reported that rhizome fragmentation had little effect on the weight of above- and below-ground biomass, whereas burial and fragmentation delayed emergence time and drying periods (12-24 h) had no effect on the yield of shoots.

Table-4. Rhizome weight (g) of *Sorghum halepense* rhizomes as affected by various moisture levels and soil depths.

Soil Depth (inches)	Irrigation			Depth means
	High	Moderate	Low	
2	3.37	3.29	1.91	2.86
4	4.09	2.82	0.75	2.55
6	2.91	4.79	3.90	3.87
Irrigation Means	3.46	3.63	2.19	

LSD(0.05) for soil depth= NS, for Irrigation= NS, for interaction= NS

Number of other weed species (broadleaf vs grassy weeds)

The analysis of the data showed that various soil depths and irrigation levels had a significant effect on the number of other weed species (Table-5). Maximum number of broad leaf weeds pot^{-1} (1.77) were noted in the shallow soil depth (2 inches) while minimum number were found in 4 inches soil depth (0.88) however it was statistically at par with the 6 inches (maximum) soil depth (1.11) as presented in Table-5. Similarly data regarding various moisture levels showed that maximum broad leaf weeds (1.55) were noted in low moisture level while the minimum broad leaf weeds (0.88) were observed in high moisture level however it was at par with the moderate moisture level (1.33). The interactions between soil depths and moisture levels were non-significant.

Table-5. Number of other weed species as affected by various soil depths and moisture levels

Soil Depth (inches)	Irrigation			Depth means
	High	Moderate	Low	
2	2.00	1.66	1.00	1.77 a
4	1.00	1.33	0.66	0.88 b
6	1.00	1.66	0.66	1.11 b
Irrigation Means	1.33 b	1.55 a	0.88 b	

LSD (0.05) for soil depth= 0.5729, for Irrigation= 0.5729, for interaction= NS

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