Green house studies on the biology of winter annual grasses and the use of cover crops and herbicides for their control

JD Ranjit, R Bellinder, C Benidict, and V Kumar*

Abstract

Greenhouse studies were initiated in two small (*Polypogon fugox)* and large (Phalaris minor) seeded annual grasses in 2007 at Cornell University, Ithaca, NY USA. These two annual grasses were very common in wheat fields of midhills and terai regions of Nepal. *P fugox* was taken for biological study. Days to emergence took 8-11 days in green house. Early emerged panicles were longer than those emerged late. Panicle took 10-12 days to emerge completely from the flag leaf. Panicles per plant were 120. Seeds were very small having about 1091 seeds per panicle. So one fully matured plant could produce seeds about 130920. Study on eco-biology needs to continue in the future. *P fugox* and *P minor* responded differently to buckwheat residues. Among different treatments emergence and growth of both weeds were suppressed more by buckwheat residues when left on the surface than incorporated. *P minor* was less affected by buckwheat residues. It might be due to larger seed compared to *P fugox*. Post emergence herbicides clodinofop and pinoxaden were effective on both grasses. Isoproturon and tralkoxydim were effective on *P fugox.* Sulfosulfuron was good in reducing plant growth to some extent. Preemergence herbicides pendimethalin and s-metolochlor were effective in reducing emergence and growth of both weeds. Isoproturon and and sulfosulfuron suppressed plant growth reducing dry plant biomass.

Key words: Grass, herbicides, buckwheat, residues, control

Introduction

Biology of Polypogon fugox

Polypogon is a monocot in the poaceae family. There are many species belonging to this genus. It is closely related to *Agrostis* (Flora of China, 2006). In Greek poly means 'many' or 'much' and pogon means 'beard' and alludes to the bristly appearance of the inflorescence. *Polypogon* is a pantropical and warm temperate genus of about 18 species. This weed has been reported as one of the important weeds in wheat. (Ranjit 2006, Rahmatullah and Bhatti 2001, Ranjit et.al 2003). Some of the species with their common names and origins are given below:

* Visiting Fellow, NARC, Horticulture Deptartment, Cornell Uni., NY USA. nepaljdr@yahoo.com

01 *P. australis* Brongn (Chilen Beardgrass) South America

02 *P. elongates* Kunth (Streambank or ditch or Southern Beardgrass) Mexico to Uruguay

03 *P. fugox* Nees ex Steudel (Asian Beardgrass, Hill Rabitsfoot grass) Iraq to Burma

04 *P. imberbes* (Philippi) Johow (Short-haired Beardsgrass) South America

05 *P. interruptus* Kunth (Dicth beardgrass, ditch polypogon) USA to Argentina

06 *P. maritimus* Willdenow (Mediterranean Beardgrass) Mediterranean region

07 *P. monspeliensis* (L) desfontaines (Annual Rabbitsfoot-grass) S Europe to Turkey

08 *P. veridis* (Giuan) Breistroffer (Water Beardgrass, Beardless Rabbitsfoot grass) S Europe to Pakistan

09 *P. semiverticillatus* (Forsk) Hyl (Water-bent)

10 *P. hissaricus* (Roshervitz)Bor

11 *P. invanovae* Tzvelv

12 *P. littoralis*

Distribution

Polypogon fugax is native from Iraq to Myanmar [Burma]. It was collected in Santa Barbara, California, and from salt marshes around Oakland, California, in the nineteenth century, and from Portland, Oregon, in the early twentieth century. The species has been reported to grow from 100 – 3600 m altitude in Anhui, Fujian, Guangdong, Guangxi, Guizhou, Henan, Hubei, Jiangsu, Shaanxi, Shandong, Shanxi, Sichuan, Taiwan, Xinjiang, Xizang, Yunnan, Zhejiang [Bhutan, N India, Japan, Kazakhstan, Korea, Kyrgyzstan, Myanmar, Nepal, Pakistan, Russia, Tajikistan, Turkmenistan, Uzbekistan; SW Asia; introduced elsewhere] (Flora China 2006).

Methodology

Polypogon fugox seeds obtained in India were grown in greenhouse trials for biological studies. First seeds were germinated in the Petri dishes in growth chambers to determine the time required for emergence. Emerged seedlings were transplanted into pots and allowed to grow for the further study. Time to emergence, heading, maturity, and other yield attributes were recorded. Sub-irrigation in the beginning and surface irrigation in the later stage were done. After heading, 5-8 seed heads were selected and covered with pollinated bags for the study of seed number per plant. Emerged panicles were counted and clipped at frequent intervals. Seed heads that emerged after clipping were counted separately. Early emerging panicles were harvested 115-117 days after seeding. Data were recorded for 3 tillers from each plant.

Result and discussion

Polypogon seeds germinated after 7 days in the growth chamber. However emergence took 8-11 days in the greenhouse. *Polypogon* plants grown in pots were erect to prostrate tufted, and

highly tillered. Leaves were dark green in color. Sheaths were smooth, and ligules membranous and acute. Auricles were absent, and leaf blades were 0.6 cm wide. Mean plant height was 39.6 cm (ranged from 29-59.8 cm). The mean distance from node to node was 7.2 cm (ranged from 5-9.5 cm). The mean length from node below flag leaf to tip of the flag leaf was 19.4cm (ranged from 11-28 cm). The mean length of flag leaf was 10.2 cm (ranged from 4.5-17.5 cm). Panicle initiation started 50 days after seeding. Early emerging panicles were bigger than those that emerged after clipping. Panicles took 10-12 days to emerge completely from the flag leaf. The number of panicles per plant was 120. The number of panicles emerged per plant after clipping was 102. The mean panicle length was 6.9 cm (ranged from 4.9-10.6 cm). Seeds are very small. Seeds per panicle were 1398. Therefore, one plant could produce as many as 167,760 seeds in one season. If the late emerged panicles also produce seeds in the same range, then its seed accumulation in the seed bank will be quite high. It is recommended to count the number of seeds per panicle from late emerged heads because many farmers cut weeds in between the vegetative stage and panicle initiation for the livestock feed. This study showed that many heads emerged after clipping (Table1).

Table 1. Plant height, seeds per panicle, plant, number of panicle of Polypogon

Different parameters of *Polypodon fugox*	
Plant height cm	39.6 (ranged from 29-59.8 cm)
Distance from node to node cm	7.2 (ranged from 5-9.5 cm).
Length from node below flag leaf to tip of flag leaf cm	19.4 (ranged from 11-28 cm).
Length of leaf below flag leaf cm	12.8
length of flag leaf cm	10.2 (ranged from 4.5-17.5 cm)
Width of flag leaf blade cm	0.6
Panicle length cm	6.9 (early; ranged from 4.9-10.6 cm), 3.2 (late)
# of panicles/plant	
Early	120 (ranged from 87-167)
Late (after clipping)	102
Seeds /panicle	1091 (ranged from 345-2429)
Seeds/plant early	130920
Seeds/plant late	-
500 seed wt g	0.0084

Figure 1. *Polypogon fugox* a-different plant parts, b; panicles c ; -membranous auricle

Effect of buckwheat cover crop residue on the emergence of small and large seeded annual grass weeds

Buckwheat residues have been reported to suppress many weed species. Recent studies conducted by Kumar et al, indicated that emergence of *Amaranthus* sp, and *Galinsoga ciliata*, were suppressed by buckwheat, ryegrass, yellow mustard, and brown mustard residues. Barnyardgrass was not affected by buckwheat residues.

Methodology

This pot study was initiated to determine the effect of buckwheat residue on emergence and growth of *Polypogon fugox* (small seed) and *Phalaris minor* (large seed). The experiment was replicated four times. The treatments included a bare soil, buckwheat residues incorporated, and buckwheat residues left on the surface. Buckwheat was seeded in flats for 35 days. Freeville field soil and Cornell mix soil were mixed in the ratio of 3:1 before buckwheat seeding. These soils were thoroughly mixed. After 35 days buckwheat plants were incorporated in the soil mixture for the incorporation treatment. For the surface application buckwheat plants were chopped into small pieces and applied on the surface of the soil. Buckwheat was planted on Oct 8, 2007 and incorporated on Nov. 13, 2007. Weeds were seeded on the same day residues were incorporated. Emerged *Polypogon* and *Phalaris* were counted at intervals of 6-7 days after seeding. Dry biomass was recorded after cutting the plants at the soil surface 18 days after of seeding. The emerged weeds were converted to percent emergence. Statistical analysis was performed using **AMD** package.

Results and discussion

Weed species responded differently to buckwheat residues. Emergence and growth of *Polypogon fugox* was suppressed more by buckwheat residue than was *Phalaris minor*. Emergence of *Polypogon* was suppressed more when residues were left on the surface than when they were incorporated. Plant growth was reduced when residues were left on the surface or incorporated compared to bare soil.

There was little effect of buckwheat residues on *Phalaris minor* emergence. However, growth was significantly reduced by both incorporation and surface buckwheat residues (Table 2). Buckwheat residues could be used to manage these weeds in wheat.

Table 2. Effect of buckwheat mulch on emergence and growth of grass weeds 2007

Untreated	*Polypogon fugox*				*Phalaris minor*			
	% emergence 8DAS	% emergence 14 DAS	% emergence 18 DAS	Drywt/plgm 18 DAS	% emergence 8 DAS	% emergence 14 DAS	% emergence 18 DAS	Drywt/ pl gm 18 DAS
	22a	50a	58a	0.0005a	16a	23a	28ab	0.0043a
Buckwheat incorporated	8b	26b	28b	0.0002b	13a	24a	29a	0.0014c
Buckwheat surface application	1c	6c	7c	0.0002b	11a	19a	23b	0.0020b
LSD=.05	6.5	14.9	14.4	0.0002	5.2	6.4	4.7	0.0005
SD	4.0	9.3	9.0	0.0001	3.3	4	2.9	0.0003

Figure 2. Effect of buckwheat residue on *Phalaris minor* (left) and *Polypogon fugox* (right)

Response of Polypogon fugox and Phalaris minor to post emergence herbicides

Polypogon fugox is a common weed in wheat crop in Pakistan (Memon et al, 2003), and has been reported in wheat growing areas of Nepal (Ranjit et al. 2006). However, this weed was rated as 3rd among the grass and broadleaf weeds (Nepal challenge to wheat Production Internationally, CIMMYT, ACIAR, NWRP). Research on the management of this *Polypogon* with herbicides has been lacking.

Methodology

A greenhouse experiment was initiated to evaluate the effect of post emergence herbicides on *Polypogon fugox* and *Phalaris minor*. The treatments included an untreated check,

isoproturon 4.17 SC @ 1457 g ai/ha, sulfosulfuron 75 DF 25g ai/ha, clodinafop 2 EC 60g ai/ha, tralkoxydim 40 WG 280 g ai/ha, and pinoxaden 0.84 EC 60.5 g ai/ha. The experiment was replicated thrice. Herbicides were sprayed at 6, 4 and 2 leaves stage. A spray chamber was used to spray the herbicides. Cornell mix soil was filled in the white styrofoam trays of 12 in by 4 in for this study. The weed seed source was from Nepal in 2001 (*Phalaris minor*) and India in 2007 (*Polypogon fugox*). *Polypogon* was seeded on Sep. 18, 21, and 24 for 6, 4 and 2 leaf stages respectively. *Phalaris minor* was seeded on Sep. 21, 24, and 28 for 6, 4, and 2 leaf stages respectively. Pots were sub- irrigated until the day of herbicide application. Ratings on chlorosis and stunting were done at 5 and 10 DAA (Days After Application). Biomass was taken on 8 and 22 days after application and dried in the oven.

Result and discussions

Polypogon fugox

Both species emerged 7-9 days after seeding. Almost all the herbicides were effective but at different growth stages. Isoproturon was highly effective at all leaf stages. The percent cholosis ranged from 98-99 at 5 DAA. By 10 DAA, the plants were virtually controlled. Sulfosulfuron and tralkoxydim did not cause symptoms by 5 DAA. But by 10 DAA sulfosulfuron caused 26 percent chlorosis in 2 leaf stage plants. Tralkoxydim caused 88-94 percent chlorosis in all the leaf stages. Pinoxaden caused 11 (6 leaf) -25% (2 leaf) chorosis 5 DAA. Clodinofop caused some chlorosis 5 DAA. But all these clodinofop, pinoxaden and tralkoxydim showed chlorosis in all 3 leaf stages from 88-99 percent by 10 DAA. Isoproturon was effective in all leaf stages within one week of application.

All the herbicides except sulfosulfuron reduced the dry weight in 6 and 4 leaf stages in 8 DAA. But dry wt were not significantly different in 2 leaf stage in 8 DAA and 10 DAA in all the herbicide treatments. All the herbicides reduced the dry biomass of plant in 6 and 4 leaf stages by 22 DAA except sulfosufuron applied to 6 leaf plants. *Polypogon* can be effectively controlled using these herbicides (Table 3)

Phalaris minor

Isoproturon and sulfosufuron did not control *Phalaris minor* any growth stage. But clodinofop and pinoxaden caused 30- 68 percent choloris in all the stages of *P. minor* by 5 and 10 DAA. Tralkoxidim caused chlorosis but regrowth occurred 4 weeks after application. Panicle initiation was also similar to the untreated check in tralkoxydim treatment. Plant dry weight biomass was significantly reduced by clodinafop and pinoxaden in 8 and 22 DAA. However dry weight biomass in isoproturon, sulfosulfuron and tralkoxydim treatments were comparable to the untreated check. Clodinofop and pinoxaden are effective in controlling all 3 stages of *P. minor* (Table 4).

From the present greenhouse study it can be concluded that clodinofop, pinoxaden are effective for both annual grass weeds. Isoproturon and tralkoxydim are effective on *P. fugox*. Sulfosulfuron is effective in reducing plant growth to some extent.

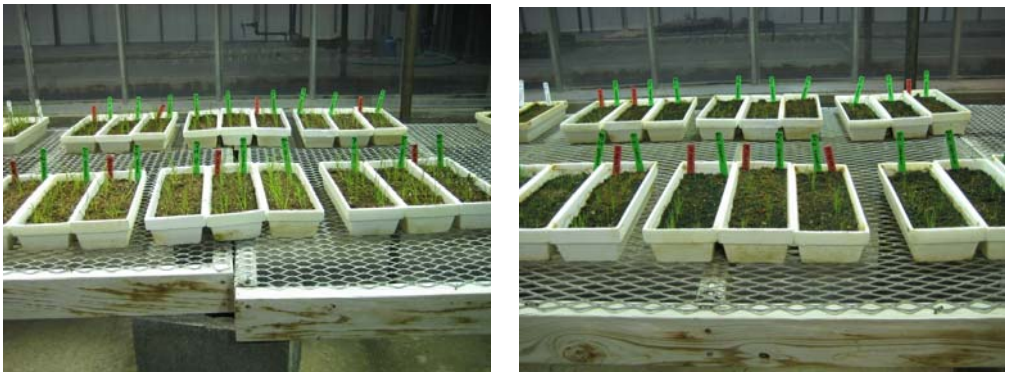

Figure 3. Effect of post emergence herbicides on *P.minor* (left) and *P fugox* (right)

Table 3. Effect of post emergence herbicides on emergence and growth

Treatments	Polypogon fugox																				
	# of *P.fugox*			%Chlorosis						%Stunt						DRW g/plant					
	6 DAA			5 DAA			10 DAA			5 DAA			10 DAA			8 DAA			22 DAA		
	6L	4L	2L	6L	4L	2L	6L	4L	2L	6L	4L	2L	6L	4L	2L	6L	4L	2L	6L	4L	2L
Untreated	14a	33a	46a	0d	0c	0d	0c	0c	0c	0b	0d	0f	0b	0b	0b	0.030a	0.017a	0.008a	0.079a	0.107a	0.086a
Isoproturon 4.17SC @ 1457 g ai/ha	14a	26a	23b	98a	99a	99a	99a	99a	96a	99a	99a	99a	0b	0b	0b	0.004c	0.002d	0.001b	0.000b	0.001c	0.000b
Sulfosulfuron 75DF @ 25 g ai/ha	13a	25a	25b	0d	0c	0d	0c	0c	25b	0b	2c	12e	10a	12a	14a	0.012b	0.009b	0.003b	0.035ab	0.049b	0.017b
Clodinofop 2EC @ 60 g ai/ha	16a	29a	28b	3c	4c	11c	98a	98a	99a	0b	6b	22d	0b	0b	0b	0.005c	0.002d	0.001b	0.004b	0.002c	0.002b
Tralkoxydim 40WG @ 280 g ai/ha	16a	20a	24b	0d	0c	0d	92b	88b	94a	0b	5b	30c	0b	0b	0b	0.006c	0.005c	0.001b	0.003b	0.003c	0.009b
Pinoxaden 0.84EC @ 60.5 g ai/ha	11a	26a	23b	11b	13b	25b	98a	98a	98a	0b	4b	42b	0b	0b	0b	0.004c	0.004c	0.001b	0.002b	0.001c	0.000b
LSD=.05	10.2	13	15.8	2.7	4.6	4.6	2.1	1.6	5.8	0	1.7	5	0	2.1	3.8	0.004	0.002	0.002	0.050	0.026	0.024
SD	5.7	7.3	8.9	1.5	2.6	2.6	1.2	0.9	3.2	0	1.0	2.8	0	1.2	2.2	0.003	0.001	0.001	0.028	0.015	0.013

Table 4. Effect of post emergence herbicides on emergence and growth

Treatments	*Phalaris minor*																				
	# of *P.minor*			%Chlorosis						%Stunt						DRW g/plant					
	6 DAA			**5** DAA			**10** DAA			**5** DAA			**10** DAA			**8** DAA			**22** DAA		
	6L	**4L**	**2L**	**6L**	**4L**	**2L**	**6L**	**4L**	**2L**	**6L**	**4L**	**2L**	**6L**	**4L**	**2L**	**6L**	**4L**	**2L**	**6L**	**4L**	**2L**
Untreated	26 a	30 a	29bc	0c	0c	0c	0d	0d	0b	0a	0c	0c	0a	0d	0c	0.146a	0.093a	0.022a	0.605a	0.368ab	0.297a
Isoproturon 4.17SC @ 1457 g ai/ha	28a	31 a	35 a	0 c	0c	0c	0d	5c	0b	0a	0c	0c	0a	0d	0c	0.141a	0.076ab	0.015b	0.562ab	0.141a	0.164b
Sulfosulfuron 75DF @ 25 g ai/ha	29 a	32 a	32 ab	0 c	0c	0c	0d	0d	0b	0a	0c	0c	0a	5bc	0c	0.140a	0.064b	0.01bc	0.469b	0.332ab	0.127b
Clodinofop 2EC @ 60 g ai/ha	29 a	27 a	27bc	32a	42a	38a	55b	45b	43a	0a	6b	6a	0a	3c	30a	0.088b	0.029c	0.006c	0.066c	0.026cd	0.008c
Tralkoxydim 40WG @ 280 g ai/ha	26 a	30 a	25c	8b	6b	3c	6c	3cd	3b	0a	1c	0c	0a	8a	12b	0.162a	0.060b	0.012b	0.485b	0.198bc	0.016c
Pinoxaden 0.84EC @ 60.5 g ai/ha	26 a	29 a	32ab	35a	43a	30b	68a	58a	43a	0a	12a	1b	0a	7ab	2c	0.055b	0.026c	0.005c	0.052c	0.017d	0.005c
LSD=.05	5.3	5.3	5.1	6.9	3.0	4.5	4.5	4.5	6.1	0	2.4	0.4	0	2.5	4.2	0.034	0.028	0.005	0.116	0.177	0.053
SD	3	3	2.9	3.9	1.7	2.5	2.5	2.5	3.4	0	1.3	0.2	0	1.4	2.4	0.019	0.016	0.003	0.065	0.099	0.029

DAA=Days after application

Response of *Polypogon fugox* and *Phalaris minor* to pre emergence herbicides

Methodology

This experiment was initiated in green house to evaluate the effect of preemergence herbicides on *Polypogon fugox* and *Phalaris minor*. The treatments were an untreated check, isoproturon 4.17 SC @ 1457 g ai/ha, sulfosulfuron 75 DF @ 25 g ai/ha, pendimethalin 3.3EC @ 1120.9 g ai/ha, and s-metolochlor 7.62 EC @ 1053.6 g ai/ha. The experiment was replicated four times. Herbicides were sprayed one day after seeding. Spray chamber was used to spray the herbicides. Cornell mix soil was filled in the white styrofoam trays of 12 in by 4 in for this study. One hundred (*Polypogon*) and forty (*Phalaris*) seeds were seeded per flat on Oct. 10, 2007. Plant emergence was taken 8 DAA and 21 DAA (days after herbicide application), Dry biomass per plant was recorded 21 DAA.

Result and discussion

Polypogon fugox

Sulfosulfuron, sp pendimethalin and s-metolochlor suppressed emergence and growth of *Polypogon* 8 DAA growth of some emerged plants was suppressed by isoproturon and sulfosulfuron. Dry weight biomass per plant was significantly reduced by all the herbicides compared to the untreated check. This study showed that pendimethalin and s-metolocholr are effective in suppressing the emergence and growth of *Polypogon.* However, isoproturon and sulfosulfuron effectively suppressed plant growth (Table 5).

Phalaris minor

S-metolachlor significantly reduced the emergence of *Phalaris minor* 8 and 21 DAA. Percent emergence was more than 60 in untreated, isoproturon and sulfosulfuron treatments. Plant growth was significantly reduced by pendimethalin and s-metolochlor compared to isoproturon and sulfosulfuron. But when compared to the untreated check, isoproturon and sulfosulfuron also significantly reduced dry weight biomass. This study showed that pendimethalin and s-metolochlor were effective in reducing emergence and growth of *P.minor* (Table 5).

Table 5. Effect of pre-emergence herbicides on emergence and growth

	Polypogon fugox			***Phalaris minor***		
	% emergence at 8 DAA	% emergence at 21 DAA	Dry wtg/ Plant 21 DAA	% emergence at 8 DAA	% emergence at 21 DAA	Dry wtg/ Plant 21 DAA
Untreated	7a	12a	0.0057a	63a	73ab	0.063a
Isoproturon 4.17 Sc @ 1457 g ai/ha	7a	2b	0.0000b	53a	78a	0.034c
Sulfosufuron 75DF @ 25 g ai/ha	4b	9a	0.0004b	55a	63bc	0.046b
Pendimethalin 3.3EC @ 1120.9 ai/ha	0c	0b	0.0000b	61a	57c	0.004d
S-Metolacholr 7.62 EC @ 1053.6 g ai/ha	0c	0b	0.0000b	34b	35d	0.013d
LSD=.05	2.6	5.2	0.0014	14.2	12.6	0.012
SD	1.7	3.4	0.0009	9.5	8.3	0.008

Acknowledgements

Authors are very much thankful for the fund and greenhouse to conduct these studies. The first author is grateful to Nepal Agricultural Research Council for giving permission to attend this program and Prof. R Bellinder, Horticulture department, Cornell University, Ithaca, NY, USA for inviting to initiate this research work.

References

Composite list of weed. 1998. WSSA, 309W, Clark Street Champaign, Illinois.

Flora of China. 2006. 22:261-263 (www:/efloras.org)

Flora of Pakistan (www:/efloras.org)

Flora of Taiwan (www:/efloras.org)

http:nzflora.landcareresearch.co.nz

http:www. Flagchem.com

Rahmatullah, Qureshi and G Raza Bhatti. 2001. Determination of weed communities in wheat (*Triticum aestivum* L) fields of district Sukkur. Pak J. Bot. 33(1):109-115

Ranjit, JD, R Bellinder, P Hobbs, N Rajbhandari, and P Kataki. 2007. Mapping *P minor* under the rice-wheat cropping system in different agro-ecological regions of Nepal. Nepal Agriculture Research Journal vol.7, pp 54-63, 2007.