Kasetsart J. (Nat. Sci.) 39 : 12 - 23 (2005)

Influence of Tillage, Fertilizer, and Weed Management on Weed Seed Bank at Various Soil Depth of Wheat Production Field In Ethiopia

Kassahun Zewdie[1] , Rungsit Suwanketnikom[2], Sombat Chinawong[3], Chairerk Suwannarat[4], Sunanta Juntakool[2] and Vichan Vichukit[2]

ABSTRACT

Screen house experiments were conducted on two soil types at two locations of central highlands of Ethiopia during 2002 / 2003 to determine the combined effects of tillage, fertilizer, and weed management on weed seed bank at various soil depths in bread wheat *(Triticum aestivum L.)* field. Among the dominant weeds identified in the soil seed bank and in the field, 89 % of the majority of the weeds were annuals and 11% of them were perennials and biennials. From the total weed species, only few were the most dominant species including *Polygonum nepalense, Galinsoga parviflora, Plantago lanceolata, Gnaplium unions, Sonchus arvensis, Spergula arvensis, Anagalis arvensis, Commelina benghlensis, Corrigiola capensis* from broad leaf weed species and *Setaria* spp.*, Bromus pectinatus, Snowdenia polystachya* and *Phalaris paradoxa* from grass weed species. The results revealed that tillage, fertilizer and weed management systems had significant effects on weed seed bank. The weed seed bank distribution and seed bank size differed among tillage treatments. The total amount of weed density tended to increase more in no tillage than conventional tillage or moldboard plow at both locations. The highest number of seed density in 0-30 cm depth of soil was found in the Kuyu black soil followed by Holetta red soil. In the NT system a large amount of weed seed was found in the depth of 0-10 cm followed by CvT and MP. The densities of broad leaf and grass weed seed were higher in NT than in CvT or MP at both locations. The highest percentages of weed seed reduction across locations were recorded 80 and 62% on MP and CvT or NT respectively. Tank mixture of fenoxaprop-P-ethyl and fluroxypyr +MCPA resulted in a significant reduction ranged from 70 to 80% of total weed number followed by hand weeding twice at all locations. The interactions between tillage and soil depth and between soil depth and weed management were species specific. Significant interactions were resulted from *Spergula arvensis,, Corrigiola capensis, Polygonum nepalance and Galinsoga prviflora* weed seed bank size. More than 60% of broad leaf and grass weeds were suppressed by tillage. Weed management was more important than tillage in affecting the weed seed bank size.

Key words: tillage, weed management, weed seed bank, wheat

[1] Ethiopian Agricultural Research Organization, Holetta Agricultural Research Center P.O.Box 2003 Addis Abeba, Ethiopia E-mail **Kassahunzewdie@yahoo.com**

[2] Department of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.

[3] Department of Agronomy, Faculty of Agriculture, Kasetsart University, Kamphaeng Sean, Nakhon Pathom 73140, Thailand.

[4] Department of Soil Sience, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.

Received date : 04/11/04 Accepted date : 04/02/05

INTRODUCTION

Size and composition of the seed bank as well as aboveground weed flora reflect past and present weed, crop, and soil management (Roberts and Neilson ,1981). Reducing the size of the weed seed bank has been a long-term goal of weed management strategies, especially for fields cropped continuously (Schweizer and Zimdahl, 1984).

Conservation tillage is one of the most important changes that have taken place in the development of sustainable agriculture systems (Swanton *et al*., 1999; Tanner, 1999). Changes in tillage practices can affect weed population dynamics, including weed seed distribution and abundance in the soil (Mulugeta and Stoltenberg, 2001). Conventional tillage brings weed seeds to the surface where they can germinate and be desiccated by additional tillage (Akobundu, 1987).

Weed seed depth in the soil influences germination and seedling development. Seed at or just below the soil surface often germinate more than seed buried deeper in the soil. Weed species with long dormancy are favored by plowing. Seed buried deep in the soil also take longer to emerge and develop seedling characteristics than seed placed shallow (Mester and Buhler, 1991).

Some researchers have mentioned the use of herbicides to reduce seed number and species composition of the seed bank. Herbicides selected for use are partly dictated by chosen crop rotation sequences. Schweizer and Zimdhal (1984), on the other hand, reported a steady decline in total seed bank densities in plots receiving repeated herbicide applications regardless of the type herbicide used.

Several experiments have revealed that nitrogen fertilizer has a positive influence on weed emergence and growth (Fawcett and Slife, 1978; Amanuel and Tanner, 1991; Peterson and Nalewaja, 1982). Fertilizers can increase weed density and biomass (Carlson and Hill, 1986). Nitrogen fertilizer was found to increase the development and growth of nitrophilous species such as common lamb quarters (Haas and Streibig, 1992). More over, addition of fertilizer can also lead to an overall depletion of the weed seed bank because fertilizers containing nitrates or nitrites can stimulate the germination of dormant seeds (Egley, 1986).

From a weed management stand point, this study will generate information that helps to develop an effective integrated weed management strategy, an understanding of the mechanisms that will determine the long term dynamics of the weed flora which is economically acceptable and ecologically sound for all wheat growing areas of the country. In order to sustain yields and encourage wheat growers by reducing weed competition, it is important to study weed control management, which includes tillage, fertilizer and weed management practices in an integrated manner with different soil depths.

The principal objective of this study was, therefore, to determine the effects of tillage, fertilizer and weed management practices on the size, distribution, and composition of the weed seed bank in wheat production in central highlands of Ethiopia.

MATERIALS AND METHODS

The screen house experiment was conducted in 2002 /2003 cropping season to determine the weed seed bank composition at the Holetta (09° 03’N, 38° 30’E, 2400 m.a.s.l) Research Center of the Ethiopian Agricultural Research Organization (EARO) in the central highlands of Ethiopia. The experiment was based on the field experiment. Two soil types were considered at Holetta nitosol and Kuyu black clay vertisol with a pH of 4.59 and 4.77 and organic matter contents of 2.71 and 5.63% respectively. At both locations the average monthly mean minimum temperatures during the crop-growing season were 6.4°C and the corresponding average monthly mean maximum temperatures were 21.3°C, with total annual rainfall of 924.5 mm.

The field experiment design was arranged as a randomized complete block split-split-split plot, 3 by 3 by 5 by 3 factorial with three replications. While the tillage treatments were assigned to the main plot, three fertilizer treatments as the sub-plot, five weed management treatments as the sub-sub-plot and the three depth increments were considered as sub-sub-sub-plots, which followed the weed management treatments. The treatments included three tillage-systems including no-tillage, conventional tillage or oxen plow and moldboard plow, three fertilizer levels including 0-0, 60-69 kg/ha basal application and 60-69 kg/ha split application of N-P_2O_5, three depths of soil 0-10, 10-20, 20-30 cm and five weed managements including cultural and chemical weed control treatments that included three post emergence herbicides fluroxypyr + MCPA, fenoxaprop-P-ethyl, and a tank-mixture of fluroxypyr + MCPA + fenoxaprop-P-ethyl, two hand weeding at 25 and at 55 days after emergence (DAE) and un weeded control.

The soil samples were collected two times, before wheat planting after land preparation in June 2002 and after wheat harvest in November 2002 to determine the weed seed bank composition. Samples were taken from three soil depths (0-10, 10-20 and 20 -30 cm.) in the field. From each plot, five samples of soils with a thread auger, 5 cm. in diameter and 10 cm long were taken as at random within the center of the sub-plot-sub plot.

Soil samples from each plot were pooled within the same depth. Soil samples were placed in plastic bags, and stored in the dark place at 4°C for two weeks before analysis in the room. The soil samples from each plot were thoroughly mixed air dried and sieved through a 3-mm mesh to break up large soil peds. The entire soil sample, minus large rocks and root fragments, was transfered into a 20 by 35 cm plastic tray and with 2-cm soil thickness, placed in light screen house and watered as required to allow germinate. The screen house temperature ranged from 6.4°C minimum to 21.3°C maximum. Weed seedlings emerged were identified, counted, and removed. Seedlings of unidentified weeds were transplanted into pots and grown until their identities could be verified. Watering was continued for three weeks after seedling emergence ceased, then the soil was air dried (3-5 days), thoroughly mixed, and rewetted to permit further germination. This process was repeated until no more seedlings emerged. Finally the dormant seeds remained in the soil samples were separated by wet sieving. Each sample was passed through 2-mm mesh used to retain weed seeds from washed soil samples. The identified seeds were counted by species using a table mounted magnifying lens. According to Forcella (1992) apparent seed viability was determined by applying pressure to seeds. The seeds remained firm when pressed by a fine-tipped forceps during counting were considered viable. The total number of viable seeds obtained from the sum of dormant seeds and screen house seedling counted. The numbers of weed for all species in weed seed bank were expressed on the basis of soil surface area and extrapolated to a square meter.

Data were subjected to analysis of variance to determine differences among tillage, fertilizer, depth and weed management treatments, with locations analyzed separately using the General Linear Model procedure of the SAS (SAS 1990). Duncan's Multiple Range Test was used to compare treatment means. The number of weed seeds density were transformed using the square root of transformation the "actual counts + 1.0" to ensure the homogeneity of variance prior to statistical analysis. Percent reduction (R) was calculated from the experimental data of each treatment using the formula as follows:

$$R = \frac{a - b}{a} \times 100$$

Where a = number of seeds in the soil before crop planting; b=number of seeds in the soil after crop harvest.

RESULTS AND DISCUSSION

Species composition

Fifty-one weed species were identified in the soil seed bank. Eighty nine percents of the weed were annuals and 11% of them perennials and biennials. The composition of different families and the number of species per family found in the weed seed bank for each locations are shown in (Table 1). From the total weed species identified, only few were the most dominant including *P. nepalense, G. parviflora, P. lanceolata, G.unions, Spe.arvensis A. arvensis, C. capensis, C. benghlensis,* from broad leaf weed species. Similarly, grass weed species including *S.*spp., *B. pectinatus, E. colona, S. polystachya* and *P. paradoxa* were the major and most prevalent weeds encountered at the experimental sites. Among the above mentioned species, *P. nepalense, P. paradoxa , S.* spp. were commonly found at Holetta and Kuyu (Table 1). Some species that were not observed in the field were recorded in the weed seed bank. This might be due to the effect of seed dormancy period of each species in the field. However, frequent pulling of weeds in the weed seed bank might give an opportunity to emerge and keep it longer which might increase different kinds of weed species germination than in the field.

Effect of soil depth

The total weed seed bank size of each weed was higher before wheat planting than after treatment application. The vertical distribution of weed seed reduction in the soil seed bank ranged from 30 to 70% of seeds in the top 10 cm depth , 55 to 75% in the 10 to 20 cm depth, and 60 to 80 % in the 20 to 30 cm depth. (Table 2 and 3). A greater concentration of weed seed was recorded in the upper 0 - 10 cm and decreased with depth in all tillage treatments at both locations. This difference might be due to the lack of physical movement of seeds in upper compared to other depths. This research had an agreement with Roberts and Ricketts(1979), who reported that seed concentrations were higher in the 5 to 20 cm depth than 20 cm deep soil.

Effect of tillage

Size of the seed bank varied among soils and tillage treatments. The highest number of seed density in 0-30 cm depth of soil was found in the Kuyu black soil 2,927,521 followed by Holetta red soil 1,687,401 seeds/m^2. Seed density was lowest in MP at both locations ranged from 2,916 to 301,401 seeds/m^2 (data not presented).

Among the dominant weeds *G. parviflora, C. capensis P. nepalense, G. unioins,* spp. were broad leaf weed species. Similarly, grass weed species including *S.*spp., *B. pectinatus, S.polystachya* were significantly reduced by tillage. The broad leaf weed seed densities were higher compared to grasses at all locations. The densities of broad leaf and grass weed seed were higher in NT than in CvT or MP (Table 2 and 3). The mean percents of weed seed reduction across locations were recorded 64, 66 and 68% on NT, CvT and MP respectively or less after wheat harvest in all tillage systems than before wheat planting. Emergence of broad leaf and grass weed seedlings was similar in MP compared with traditional oxen plow. It could be due to uniform distribution of weed residue and recent soil aeration through tillage. Consistently the highest weed population among locations was recorded in NT. This might be due to better weed control in these tillage treatments and to the stimulatory effect of tillage in inducing weed seed germination and it might be due to the greater deposition of weed seed at soil surface and plowing each time before planting might kill the germinated weeds. This research had a general agreement with several previous studies of Ball and Miller (1990), Amanuel *et al*. (1991), Mohler (1993), Assefa and Tanner (1998).

Table 1 Scientific names, life cycles and methods of propagation of weed associated with wheat at two experimental sites in 2002 / 2003.

Scientific name	Family	Characteristics			Interference level[4]	
Broadleaf weeds		Life cycle[1]	Group[2]	Propagation [3]	Holetta	Kuyu
Amaranthus hybridus	Amaranthaceae	a	d	s	x[4]	x
Anagallis arvensis L.	Primulaceae	a	d	s	x	xx
Argemone mexicana	Papaveraceae	a	d	s	x	x
Bidens pilosa L.	Asteraceae	a	d	s	xx	xx
Caylusea abyssinica	Resedaceae	a	d	s	xx	x
Cenopodium album L.	Chenopodaceae	a	d	s	x	x
Cenopodium ambrosoides L.	Chenopodaceae	a	d	s	x	x
Commelina benghlensis	Commelinaceae	a/p	m	s/v	x	x
Commelina Africana	Commelinaceae	a/p	m	s/v	x	x
Corrigiola capensis	Caryophylaceae	a	d	s	xxx	x
Erucastrum arabicum	Brassicaceae	a	d	s	x	x
Galinsoga parviflora Cav.	Asteraceae	a	d	s	xx	xxx
Galium aparine L.	Rubiaceae	a	d	s	x	xx
Galium spurium L.	Rubiaceae	a	d	s	x	x
Gnaphalium unionis D.Don.	Asteraceae	a	d	s	x	xx
Guizotia scabra	*Asteraceae*	*a*	*d*	*s*	*xx*	*xx*
Convolvulus arvensis	Convolvulaceae	p	d	s/v	x	x
Juncus spp L.	Juncacea	a	d	s	xx	xx
Lactuca sp.L	Asteraceae	a	d	s/v	x	x
Launea corunata	Asteraceae	*a*	*d*	*s/v*	*x*	*x*
Medicago polymorpha	Legumionsae	a	d	s	x	xx
Nicandra physaloides	Solanaceae	a	d	s	x	x
Oxalis corniculata L.	Oxalidaceae	a/p	d	s/v	xx	xx
Plantago lanceolata L.	Plantaginaceae	a/p	m	s	xx	xx
Plantago major L.	Plantaginaceae	a/p	m	s	x	x
Polygonum aviculare L.	Polygonaceae	a	d	s	xx	x
Polygonum convolvulus L.	Polygonaceae	a	d	s	x	x
Polygonum nepalense L.	Polygonaceae	a	d	s	xxx	xxx
Rumex abyssinicus L.	Polygonaceae	a	d	s/v	xx	x
Spergula arvensis L.	Carophyllaceae	a	d	s	xx	xx
Tagetes minuta	Asteraceae	a	d	s	x	xx
Trifolium spp.	Leguminosae	a	d	s	x	x
Grass weeds						
Andropogan abyssinicus	Poaceae	a	m	s	x	xx
Avena fatua L.	Poaceae	a	m	s	xx	xx
Cynodon dactylon (L.)	Poaceae	p	m	s/v	x	x
Digitaria scalarium L.	Poaceae	a	m	s	x	x
Dinebra retroflexa	Poaceae	a	m	s	x	x
Echinocloa colona L.(Link.)	Poaceae	a	m	s	xx	xx
Echinocloa crusgalli (L.)Beauv.	Poaceae	a	m	s	x	x
Eleusine indica (L.) Gaertn.	Poaceae	a	m	s	x	x
Eragrostis spp.	Poaceae	a	m	s	x	x
Lolium temulentum	Poaceae	a	m	s	x	x
Panicum spp.L.	Poaceae	a	m	s	x	x
Pennisetum spp.	Poaceae	p	m	s/v	x	x
Phalaris paradoxa	Poaceae	p	m	s	xxx	xxx
Poa annua L.	Poaceae	a	m	s	x	x
Setaria pumila (L.)	Poaceae	a	m	s	xxx	xxx
Setaria verticillata (L.)	Poaceae	a	m	s	xx	xx
Snowdenia polystachya	Poaceae	a	m	s	xx	xxx
Sedges						
Cyperus esculentus L.	Cyperaceae	p	m	s/v	x	xx
Cyperus rotundus L.	Cyperaceae	p	m	s/v	x	xx

[1]Life cycle ; a= annual, p= perennial. [2] Group; m= monocot, d= dicot. [3] Propagation; s= reproduction by seed, v=reproduction by vegetative means. [4] Interferance level; XXX= major weeds,XX= important weeds, X= commonly occurring weeds.

Which reported that tillage might increase or decrease weed seedling densities of certain weed species.

Effect of fertilizer

The results indicated that in general, over the growing season at both locations most of weed

Table 2 Percent reductions of the weed seed in the soil with different tillage, fertilizer, soil depth and weed management systems at Holetta**.**

Treatments	*P.nepalense*	*C.capensis*	*S.*spp.	*P.paradoxa*
		(%)		
Tillage				
Zero tillage	37.4c [1]	55.5b	49.7b	21.7c
Oxen plow	65.6b	77.5a	31.8c	51.2b
Moldboard plow	74.1a	68.9a	66.2a	57.6a
Fertilizer				
0-0 N- P_2O_5 kg/ha	36.4c	28.9b	27.5c	42.8b
60-69 N- P_2O_5 kg/ha basal application	66.2b	78.6a	59.9b	66.7a
60-69 N- P_2O_5 kg/ha split application	75.5a	73.8a	71.7a	70.5a
Soil depth				
0-10 cm	42.8c	39.5c	49.5b	32.3c
10-20 cm	57.4b	64.7b	55.4a	48.2b
20-30 cm	66.4a	77.6a	57.9a	65.9a
Weed management				
Unweeded control	20.8b	31.4c	18.0c	19.9c
Hand weeded twice	77.7a	66.6a	46.0b	42.2b
Fenoxaprop-P-ethyl @ 0.01 kg (a. i.)/ ha	12.6c	23.2c	58.7a	57.6a
Fluroxypyr + MCPA @ 0.25 kg (a. i.)/ ha	79.9a	64.6a	19.7c	16.4c
Fenoxaprop-P-ethyl @ 0.01 kg (a. i.)/ ha + fluroxypyr +MCPA @ 0.25 kg (a. i.)/ ha	61.4ab	54.5b	41.3b	51.1a
Tillage	*[2]	*	*	*
Fertilizer	*	*	*	*
Tillage X fertilizer	ns	ns	ns	ns
Weed management	*	*	*	*
Tillage X weed management	ns	ns	ns	ns
Fertilizer X weed management	ns	ns	ns	ns
Tillage X fertilizer X weed management	ns	ns	ns	ns
Soil depth	*	*	*	*
Tillage X soil depth	*	*	ns	ns
Fertilizer X soil depth	ns	ns	ns	ns
Tillage X fertilizer X soil depth	ns	ns	ns	ns
Weed management X soil depth	ns	*	ns	ns
Tillage X weed management X soil depth	ns	ns	ns	ns
Fertilizer X weed management X soil depth	ns	ns	ns	ns
Tillage X fertilizer X weed management X soil depth	ns	ns	ns	ns

[1] Means followed by the same letters within the same column are not significantly different at the 5% level according to Ducan's multiple range test. [2]* and ** indicate significance at the 0.05 and 0.01 levels, respectively, ns indicates nonsignificant. All data were transformed by SQRT (weed count/m^2 +1.0)

responded directly to fertilizer application. Higher percent reductions of weed seed were observed on fertilized plots relative to unfertilized. Percent reductions of weed like *G. parviflora*, *C. capensis*, *Spe. arvensis* and *P. paradoxa* positively increased. Similarly *P. nepalense*, *S.* spp., and *S. polystachya* percent reduction negatively increased at both locations; which might be due to the addition effects of fertilizer (Table 2 and 3). The research result was in line with previous studies. Roberts and Neilson (1981) reported that weeds were generally more productive on fertile soils, adding more seeds to the seed bank. Egley (1986) noted that the addition of fertilizers could lead to an over

Table 3 Percent reductions of the weed seed in the soil with different tillage, fertilizer, soil depth and weed management systems at Kuyu**.**

Treatments	*P.nepalense*	*G.parviflora*	*S. spp*	*P. paradoxa.*	*S .polystachya*
			(%)		
Tillage					
Zero tillage	40.6c[1]	31.8c	19.2b	26.3b	16.4c
Oxen plow	60.6b	73.9b	59.4a	69.1a	40.5b
Moldboard plow	74.2a	85.6a	68.7a	81.3a	62.2a
Fertilizer					
0-0 N- P_2O_5 kg/ha	59.0ab	10.9c	53.6b	32.5b	26.2a
60-69 N- P_2O_5 kg/ha basal application	53.8b	22.9b	69.3a	31.4b	-61.5c
60-69 N- P_2O_5 kg/ha split application	65.7a	39.9a	-12.1c	73.9a	-2.9b
Soil depth					
0-10 cm	39.5b	34.4c	44.9b	22.2b	2.2c
10-20 cm	69.7a	73.6b	75.4a	84.3a	44.2b
20-30 cm	76.1a	83.4a	77.6a	89.6a	72.6a
Weed management					
Unweeded control	51.3b	46.9b	11.7c	45.9b	28.6c
Hand weeded twice	81.3a	73.0a	53.6ab	75.6ab	48.3a
Fenoxaprop-P-ethyl @ 0.01 kg (a. i.)/ ha	3.0c	18.7c	68.5a	78.5a	41.1ab
Fluroxypyr + MCPA @ 0.25 kg (a. i.)/ ha	79.9a	76.2a	15.9c	21.4c	13.5d
Fenoxaprop-P-ethyl @ 0.01 kg (a. i.)/ ha + fluroxypyr +MCPA @ 0.25 kg (a. i.)/ ha	79.4a	74.1a	49.2b	79.6a	37.3b
Tillage	*[2]	*	*	*	*
Fertilizer	*	*	*	*	
Tillage X fertilizer	ns	ns	ns	ns	ns
Weed management	*	*	*	*	*
Tillage X weed management	ns	ns	ns	ns	ns
Fertilizer X weed management	ns	ns	ns	ns	ns
Tillage X fertilizer X weed management	ns	ns	ns	ns	ns
Soil depth	*	**	*	*	*
Tillage X soil depth	*	*	ns	ns	ns
Fertilizer X soil depth	ns	ns	ns	ns	ns
Tillage X fertilizer X soil depth	ns	ns	ns	ns	ns
Weed management X soil depth	ns	*	ns	ns	ns
Fertilizer X weed management X soil depth	ns	ns	ns	ns	ns
Tillage X fertilizer X weed management X soil depth	ns	ns	ns	ns	ns

[1] Means followed by the same letters within the same column are not significantly different at the 5% level according to Ducan's multiple range test. [2]* and ** indicate significance at the 0.05 and 0.01 levels, respectively, ns indicates nonsignificant. All data were transformed by SQRT (weed count/m^2 +1.0)

all depletion of the weed seed bank because fertilizers containing nitrites or nitrates could stimulate the germination dormant seeds. Statistical differences were obtained between split and basal applications of nitrogen fertilizer when treatment means were compared. The highest percent reduction was observed from split application of nitrogen fertilizer. Fertilizer application in this study improved to reduce the weed seed bank density by stimulating the dormant seeds to germinate.

Effect of weed management

The results revealed that there was a significant difference between weed management on both grass and broad-leaved weed seed bank. The weed seed bank sizes of grass and broad-leaved weed before wheat planting were 2-5 folds higher than after weed management practices. The total grass and broad leaf weed seed bank densities were less in treatments hand-weeded twice @ (30-35 and 55 –60 DAE), fenoxaprop-P-ethyl @ 0.01 (kg a. i./ ha) , fluroxypyr + MCPA @ 0.25 (kg a. i./ ha) and the mixture of fenoxaprop-P-ethyl @ 0.01 (kg a. i./ ha) + fluroxypyr +MCPA @ 0.25 (kg a. i./ ha) which showed that the wheat weed management effect on grasses and broad leaf weeds respectively. The best control of both annual broadleaf and grass weeds was achieved with herbicide application followed by twice hand weeding (Table 2 and 3). Fluroxypyr +MCPA suppressed the highest percentage of broad leaf weed seed bank, *P. nepalense, G. parviflora* and *C. littoralis.* Fenoxaprop-P-ethyl was outstanding against *P. paradoxa, Setaria* spp. A mixture of fenoxaprop-P-ethyl @ 0.01 (kg a. i./ ha) + fluroxypyr +MCPA @ 0.25 (kg a. i./ ha) was significantly reduced the greatest number of broad leaf and grass weed seeds up to 75% which seemed to be of considerable potential for successful use against noxious grass and broadleaf weeds in wheat. The numbers of grass weed significantly increased in NT plot with application of broad leaf weed killers, fluroxypyr +MCPA). The study was in support by the findings of Roberts and Neilson (1981) who reported that the use of herbicide to complement standard cultivation practices could drastically reduce the population of weed seed in the soil and also emphasized that depending on herbicide use, certain species might decrease in the seed bank while others increase. All tested herbicides were not be able to suppress all weed species except the hand-weeding treatment because of large volume of the weed seed bank size in the soil. Several researchers (Rezene, 1985; Amanuel and Tanner, 1991; Kassahun and Tanner, 1998, Tanner, 1999) reported that the herbicide treatments needed to be supplemented with hand-weeding as necessary, which was depending on the weed flora and persistence of applied herbicides.

Soil depth and tillage interaction

The interaction between soil depth and tillage was species specific. Among the dominant weed species, *P. nepalense, C. capensis* and *G. parviflora* were significantly reduced by tillage system (Table 5 and 6). The weed seed bank distribution differed between tillage systems. In the NT, a large amount of weed seed was found in the depth of 0-10 cm followed by CvT and MP. Oxen plow and moldboard plow reduced more *G. parviflora* and *P. nepalense* weed seed in 10-30 cm deep. However, for *C. capensis*, tillage did not affect the numbers of seed in different soil depths. The reason might be due to the greater deposition weed seed at the soil surface. The research had an agreement with the previous work of Clements *et al.,* (1996) and Buhler *et al.,* (1994) which showed that higher weed seed density was found at the first 5 cm depth.

Soil depth and weed management interaction

The interaction effect of depth and weed management was found in *P.nepalence* and *G. parviflora* (Table 4 and 5). The weed management treatments decreased the weed seed bank of most

Table 4 Soil depths, weed management, tillage and soil depth interactions on *P.nepalence* and *C.capensis* at Holetta in 2002/2003.

Soil depth (cm)	Weed management	*P.nepalence* (%)	Tillage	Soil depth	*P.nepalence*	*C.capensis*
0-10	Unweeded control	37.9c[1]		(cm)	(%)	
	Hand weeded twice	65.5b	N0-tillage	0-10	34.1d	44.7c
	Fenoxaprop-P-ethyl	36.2c		10-20	47.2c	67.6b
	Fluroxypyr + MCPA	71.5a		20-30	54.5c	71.5a
	Fenoxaprop- P -ethyl+fluroxypyr +MCPA	69.2b				
10-20	Unweeded control	45.1c	Oxen plow	0-10	43.7c	67.1b
	Hand weeded twice	74.6a		10-20	65.9b	76.7a
	Fenoxaprop- P -ethyl	28.1d		20-30	74.9a	79.2a
	Fluroxypyr + MCPA	75.9a				
	Fenoxaprop-P-ethyl+fluroxypyr +MCPA	78.1a				
20-30	Unweeded control	31.9c	Moldboard plow	0-10	54.3c	73.5a
	Hand0weeded twice	69.1b		10-20	68.9b	69.1b
	Fenoxaprop- P -ethyl	46.2c		20-30	78.6a	72.6a
	Fluroxypyr + MCPA	77.0a				
	Fenoxaprop- P -ethyl+ fluroxypyr +MCPA	67.0b				

[1] Means with in the same column followed by the same letters are not significantly different at the 5% level according to Duncan's multiple range tests. All data were transformed by SQRT (no./m^2 +1.0)

Table 5 Soil depths, weed management, tillage and soil depth interactions on *Spergula arvensis* , *P.nepalence* and *G.parviflora* at Kuyu in 2002/2003.

Soil depth (cm)	Weed management	*Spe. arvensis* (%)	Tillage	Soil depth	*P.nepalence*	*G.parviflora*
0-10	Unweeded control	45.6cd [1]		(cm)	(%)	
	Hand weeded twice	46.7c	N0-tillage	0-10	37.5c	31.4c
	Fenoxaprop-P-ethyl	23.5d		10-20	59.5b	50.2b
	Fluroxypyr + MCPA	58.1bc		20-30	54.5b	68.3ab
	Fenoxaprop- P -ethyl+fluroxypyr +MCPA	54.7bc				
10-20	Unweeded control	53.2bc	Oxen plow	0-10	48.1c	52.9b
	Hand weeded twice	68.0b		10-20	61.4ab	71.8ab
	Fenoxaprop- P -ethyl	49.4c		20-30	62.2ab	80.9a
	Fluroxypyr + MCPA	76.4ab				
	Fenoxaprop-P-ethyl+fluroxypyr +MCPA	71.1abc				
20-30	Unweeded control	62.1b	Moldboard plow	0-10	52.7b	53.7b
	Hand weeded twice	79.6a		10-20	68.1ab	69.9ab
	Fenoxaprop- P -ethyl	54.1bc		20-30	78.1a	81.7a
	Fluroxypyr + MCPA	73.0ab				
	Fenoxaprop- P -ethyl+ fluroxypyr +MCPA	80.5a				

[1] Means with in the same column followed by the same letters are not significantly different at the 5% level according to Duncan's multiple range tests. All data were transformed by SQRT (no./m^2 +1.0)

broad leaf and grass weed species compared to un weeded control (Table 4 and 5). The mixture of fenoxaprop-P-ethyl and fluroxypyr + MCPA and hand weeding reduced *P.nepalence* seed at all soil depth (Table 4) but both herbicide and hand weeding treatments reduced *Spe. arvensis* only at 10-30 cm depth (Ttable 5).

CONCLUSIONS

Tillage, fertilizer and weed management systems had significant effects on weed seed bank. The effect of tillage on the weed seed bank varied by the soil types and locations. Weed seed bank size was greater in no tillage than conventional tillage or mold board plow at both locations.

Among the weed management treatments tested, a tank mixture of both fenoxaprop-P-ethyl and fluroxypyr +MCPA significantly reduced the greatest number of total broad leaf and grass weed seeds in the soil. Glyphosate based NT systems reduced weed seed bank densities. Herbicide combinations need to be promoted to control a broader spectrum of weed species and often permit the use of lower rates of each individual product.

From the research results it could conclude that tillage and weed management were the limiting factors of weed seed bank size in the soil. This suggested that using integrated management systems could make considerable weed seed yield reduction in the soil. However, because of the variation in fecundity estimates in the study, further research will be required to confirm these initial findings and to determine if the dynamic of individual species follow the same pattern as total weed density and which can be made more accurate long-term predictions related to the population dynamics of the weed seed in the soil.

ACKNOWLEDGEMENTS

The authors wish to thank the Agricultural Research Training Program (ARTP), of the Ethiopian Agricultural Research Organization (EARO) for funding the research. We are very grateful to the management and the staffs of Holetta Research Center for kind assistance and permission for using the research facilities while executing the field and laboratory experiments. Especial thanks are also extended to the Holetta wheat research program staffs for their assistance in conducting the experiment and data collection.

LITERATURE CITED

Akobundu, I.O. 1987. **Weed Science in the Tropics: Principles and Practices.** John Wiley and Sons. 522 p.

Amanuel, G. and D.G. Tanner. 1991. The effect of crop rotation in two wheat crop production zones of southeastern Ethiopia, pp. 491-496. *In* D.A. Saunders (ed.). Wheat for non-traditional warm areas. **Mexico, D.F.; CIMMYT**

Assefa, T. and D.G. Tanner. 1998. Stubble management, tillage and cropping sequence effects on weed populations in southeastern highlands of Ethiopia. **Arem** 4:76-88.

Ball, D.A. and S.D. Miller. 1990. Weed seed population response to tillage, and herbicide use in three irrigated cropping sequences. **Weed Sci.** 38: 511-517.

Buhler, D. D., D. E. Stoltenberg, R.L. Becker and J.L. Gunsolus. 1994. Perennial weed populations after 14 years of variable tillage and cropping practices. **Weed Sci.** 42: 205-209.

Carlson, H. L. and J. E. Hill. 1986. Wild oats (*Avena fatua*) competition with spring wheat: effects of nitrogen fertilization. **Weed Sci**. 34: 29-33

Clements, D. R., D. L. Benoit, S. D. Murphy and C. J. Swanton.1996. Tillage effects of weed seed return and seed bank composition. **Weed Sci**. 44: 314-322.

Egley, G.H**.** 1986. Stimulation of weed seed germination in soil. **Weed Sci.** 2: 67-89.

Fawcet, R.S. and F.W. Slife. 1978. Effects of field applications of nitrate on weed seed germination and dormancy. **Weed Sci**. 26: 594-596.

Forcella. F., R. G. Wilson, K. A. Renner, J. Dekker, R. G. Harvey, D. A. Alm, D. D. Buhler and J. A. Cardina. 1992. Weed seed banks of the U.S. corn belt: magnitude, variation, emergence, and application. **Weed Sci.** 40: 636-644.

Haas, H. and J.C. Streibig. 1992. Changing patterns of weed distribution as a result of herbicide use and other agronomic factors, pp 57-59. *In* H.M. LeBaron and J. Gressel (eds.). **Herbicide Resistance in Plants**. New York: J. Wiley.

Kassahun, Z. and D.G. Tanner. 1998. Pre- and Post- Emergence Herbicides for irrigated wheat in Ethiopia, pp. 309-315. *In* **The Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa,** Stelenbosch, South Africa.

Mester, T. C. and D. D. Buhler. 1991. Effects of soil temperature, seed depth, and cyanazine on giant foxtail (*Setaria faberi*) and velvetleaf (*Abutilon theophrasti*) seedling development. **Weed Sci.** 39: 204-209.

Mohler, C. L. 1993. A model of the effect of tillage on emergence of weed seedlings. **Ecological Applications** 3: 53-73

Mulugeta, D. and D. E. Stoltenberg. 2001. Weed species area relationships as influenced by tillage. **Weed Sci.** 49: 217-223.

Peterson, D.E.and J.D.Nalewaja. 1992. Environment influences green foxtile *(Setaria viridis*) competition with wheat *(Triticum aestivum*). **Weed Tech.** 6: 607-610.

Rezene, F. 1985. A review of weed science research activities on wheat and barely in Ethiopia, pp. 121-148. *In* T. Abate (ed.). **A Review of Crop Protection Research in Ethiopia.** Addis Ababa: Ethiopia; IAR.

Roberts, H. A. and J. E. Neilson. 1981. Changes in the soil seed bank of four long-term crop/ herbicide experiments. **J. Appl. Ecol.** 18: 661-668.

Roberts, H. A. and M. E. Ricketts. 1979. Quantitative relationships between the weed flora after cultivation and the seed population in the soil. **Weed Res**. 19: 269-275.

Schweizer, E. E. and R. L. Zimdahl. 1984. Weed seed decline in irrigated soil after six years of continuous corn and herbicides. **Weed Sci.** 32: 76-83.

Swanton C. J., Anil Shretha, R. C. Roy and S. Z. Knezevic. 1999. Effect of tillage systems, N, and cover crop on the composition of weed flora. **Weed Sci.** 47: 454-461.

Tanner, D.G. 1999. Principle and prospects for integrated weed management in the wheat Production systems of Ethiopia. **Arem**. 5: 27-65