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Succession of Maize (*Zea mays* L.) with some winter crops 1 – the effects on weed density and species

Hussain.Ahmad Sadalla, Ali.Mala.Galalay, Sakar.Asaad. Kakarash, Jamal Borhan. Guznay, Omar.Gharib.Haji
(Field crops Department, Agriculture College/ Salahaddin University, Erbil/ Iraq)
(Agriculture Research Center / Ministry of Agriculture / Erbil, Iraq)
Field crops, Agriculture College/ Salahaddin University, Erbil/ Iraq
Mobile: +964(0)7504554708
Email: dr.hussainsadalla@yahoo.com

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Abstract

During the years 2011 and 2012 (two fall seasons and two winter), this study was conducted at Grdarash Research Station at Erbil, the capital city of the Kurdistan Region of Iraq, to study the population and species of weeds associated with wheat, canola, broad bean, peas and in a fallow plot. These crops were planted in R.C.B.D (randomized complete block design), with three replications during both winter seasons. Maize was planted during the fall seasons succeeded by winter crops. The kind of weed species and density were determined and counted with each winter and fall maize crop plantations during the four growing seasons. The results showed great differences in total weed density among winter crops. The lowest number of both narrow and broad leaf weeds was found in the wheat crop in the two winter seasons. In 2010-2011, the numbers were 15.7 and 86.6 respectively, while in 2011-2012 were 5.7 and 38.6 respectively. We can notice that the total number of both broad and narrow leaf weeds in the winter seasons of 2010-2011 was 167.9 and 756.3 respectively, while the numbers of weeds declined in 2011-2012 to 82.8 respectively 447.1. The lowest number of the narrow and broad leaf weeds in the fall season of 2011 was found in that stage of the experiment when wheat was followed by maize. The numbers were 38.3 and 32.7 respectively. As for the fall season of 2012, the lowest number was 21.7 respectively 14.3 for narrow and broad leaves.

Introduction

The competition among weeds and crops for growth regarding limited recourses as space, light, moisture and nutrients have been reported by many researchers (Colquhoun, 2006). As well as the plant interference as physical or chemical mechanism that results in reduction of plant growth over time due to the presence of another plant (Inderjit and Watson, 2003). Dzyubenko and Petrenko in 1971 found that root secretion of maize inhibit the growth of weed species. Many types of mustard (*Brassica hirta*) are currently utilized as a full cover crop to protect against erosion, suppress weed growth (Siemens et al., 2002 and Weston 1996). (Wu et al. 2000) reported the screening results of the 453 wheat varieties which showed significant differences in their allelopathic activities. (Steinsiek et al. 1982) reported that allelopathic interference of wheat to selected weed species was dependent on extract, species and temperature. Also,

several crop species have been identified to possess potent allelopathic interference mediated by root exudation of allelochemicals as in rice, wheat and barley. With the wheat *Triticum aestivum* 32% of the field weed suppression was attributed to early vigor and allelopathy (Blez-Regina, 2007). Over 240 weed species have been reported to be allelopathic to other similar plants of the same species (auto toxicity) as other crop and weed species (Colquhoun, 2006). A diversified crop management is expected to exert a positive effect on controlling the weed flora (Tomasoni et al., 2003). On the other hand, diversified crop rotation tend to reduce the development of few primary weed species by offering different sowing and harvest times, different life cycles and different possibilities for weed control (Blez-Regina, 2007). In this study we have focused on the effect of crop succession on the weed population and diversity that are associated with each crop at each growing seasons.

Materials and methods

The field experiments were carried out at Grdarash Research Station during four seasons in 2011 and 2012 (two fall seasons and two winter seasons). Four winter crops were chosen: wheat (*Triticum aestivum* L.), canola (*Brassica napus* L.), pea (*Pisum sativum* L.), broad bean (*Vicia faba* L.) as well as a Fallow plot. During the winter seasons 2010-2011 the crops were sown in randomized complete block design (RCBD) with three replications. Each replication consisted of five plots (3 × 3) m. For each crop all the recommended cultural practices were performed including planting date, plant density, fertilization and irrigation if it was necessary. During the growing period, the weed density and species were counted and recorded for each crop at each plot. After the harvesting took place of all crops in the Spring of 2011,the plots were ploughed separately and manually to avoid soil mixture among plots in order to be prepared for the fall season of 2011. Then, the maize was cultivated in all plots using (TALAR) variety exactly on July 19th. The maize was planted in rows of 3 m length, 75 cm between rows and 25 cm within rows between the individual plants. All recommended cultural practices were performed during the growing period. Weed density and species were counted and recorded for each plot separately. After the maize harvesting took place, the soil was ploughed manually and separately and prepared to the next winter season of 2011-2012. The same process of the previous two seasons was repeated in winter season 2011-2012 and the fall season of 2012.

Table 1. The successions of crops planted during four growing seasons.

	Winter 2010-2011	Fall 2011	Winter 2011-2012	Fall 2012
1	Canola (*Brassica napus* L.)	Maize (*Zea mays* L.)	Canola (*Brassica napus* L.)	Maize (*Zea mays* L.)
2	Wheat (*Triticum aestivum* L.)	Maize (*Zea mays* L.)	Wheat (*Triticum aestivum* L.)	Maize (*Zea mays* L.)
3	Broad bean (*Vicia faba* L.)	Maize (*Zea mays* L.)	Broad bean (*Vicia faba* L.)	Maize (*Zea mays* L.)
4	Pea (*Pisum sativum* L.)	Maize (*Zea mays* L.)	Pea (*Pisum sativum* L.)	Maize (*Zea mays* L.)
5	Fallow	Maize (*Zea mays* L.)	Fallow	Maize (*Zea mays* L.)

Result and discussion

The winter seasons 2010-2011 and 2011-2012 revealed that there were differences in total weed density among the crops (Tables 2 and 3). The lowest weed density was found in wheat crops and higher density in canola crops. Associated weeds show that the narrow leaf weeds were less than the broad leaf. They were about 167.9 and 756.3 in 2010-2011, 82.8 and 447.1 in 2011-2012 respectively. As well as the wheat crops had less weed density than other crops, because of phytotoxic nature of the wheat (Bader et al., 2001). The major narrow leaf weed was (*Avenal fatua* L.) and the major broad leaves were (*Fumaria officinallis*) and (*Vaccaria pyremrdata*) for the two winter seasons.

The ratio of the narrow leaf declined was about 64% in wheat crops, 57.5% in pea crops and 55% in broad bean crop, while of the broad leaf weeds was 50.1% in wheat and 52.4% in pea. In general, the decline percentage in the narrow leaf weed density was higher than in the broad leaf weeds as shown in (Figs. 1 and 2). It was 50.6% to 40.8% respectively.

In the fall season of 2011, the maize plots showed that the broad leaf weed density was higher than the narrow leaf weeds, 290.9 and 235.6 respectively (Table 4). There was a great difference in the total weed density in wheat-maize compared to the total weed density in the canola-maize and the broad bean-maize. The major narrow leaf weed in the fall season of 2011 was (*Echinochla colonum* L.) and the major broad leaf weed was (*Convolvulus arvensis* L.).

Table (5) represents the total weeds in the fall season of 2012. In the maize plots the narrow leaf weed density was more than the broad leaf density. There were no great differences in the total weed density at maize crop succession of different winter crops. The decline in weed density in percentage is shown in (figs 3 and 4). The ratio of broad leaf decline in canola-maize was 60.3% and 53.9% in pea-maize. While the declined percentage in the narrow leaf weed density was 59% in broad bean-maize, 23.4% in wheat-maize and 43.7% in canola-maize. From present study we can deduce that there are differences among winter crops when it comes to weed density. That is because, according to many reports, different crops either have allelopathic activities or phytotoxic nature which affects certain weed species (Belz-Regina, 2007).

We can conclude that the differences in weed density may be due to the allelopatic activities or the toxic substances found in each crop; or may be due to the accumulation of these substances during the two seasons; or the interaction between winter crops and substances exuded from the roots of the maize which affect some species of weeds (Bader et al., 2001 and Wu et al., 2000); or the natural competition of different crops with the weeds.

Table 2. Number of weeds associated with winter crops during the first winter season 2010-2011

The weeds	**No. of weeds/ plot for winter crops**					**Total**
Narrow leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	
Avena fatua	15.7	19.7	25.0	0.0	16.3	76.6
Phalaris minor	0.0	11.7	0.0	17.3	9.3	38.3
Lolium temulentam	0.0	12.0	8.7	15.3	14.7	50.6
Setaria glauca	0.0	0.0	0.0	0.0	2.3	2.3
Total	15.7	43.3	33.7	32.6	42.6	167.9
Broad leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	**Total**
Fumaria officinalis	15.7	23.7	21.3	26.7	22.0	109.2
Cardaria draba	11.0	16.7	5.7	15.3	17.7	66.3
***Rumex* spp.**	0.0	7.30	3.7	9.0	0.0	20.0
Brassica nigra	12.0	14.0	5.7	9.0	14.0	54.7
Vaccaria pyramedata	14.0	16.7	26.3	19.0	27.7	103.7
Melilotus officinalis	12.7	13.7	17.0	19.3	10.0	72.6
***Silene* spp.**	0.0	24.0	0.0	0.0	3.7	27.7
Silybum marianum	2.7	6.7	6.3	0.0	5.7	21.3
Carthamuso xyacanthus	0.0	3.3	0.0	0.0	0.0	3.3
Centaurea iberica	1.7	2.7	3.0	0.0	1.3	8.6
Ammi majus	0.0	8.3	0.0	6.0	0.0	14.3
Convolvulus arvensis	4.7	19.3	8.7	27.0	3.7	63.3
Galium tinoctoria	7.3	13.7	9.3	11.7	11.7	53.6
Anagalis arvensis	0.0	19.7	3.0	13.3	11.3	47.3
Ranunculus arvensis	0.0	0.0	3.67	0.0	6.7	10.3
Polygonum aviculare	0.0	11.0	17.3	0.0	13.0	41.3
Capsella bursa-pastoris	1.3	0.0	0.0	0.0	3.7	5.0
***Sonchus oleraceus* L.**	0.0	0.0	13.7	0.0	0.0	13.7
Matricaria chamomilla	3.7	0.0	0.0	2.3	0.0	6.0
***Malva parviflora* L.**	0.0	0.0	3.0	0.0	0.0	3.0
***Plantago lanceolata* L.**	0.0	0.0	0.0	0.0	4.0	4.0
Crepis cappilaris	0.0	0.0	7.0	0.0	0.0	7.0
Total	86.6	200.6	154.6	158.5	156.0	756.3

Table 3. Number of weeds associated with winter crops during the second winter season 2011- 2012

The weeds	No. of weeds/ plot for winter crops					Total
Narrow leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	
Avena fatua	5.7	4.7	11.7	0.0	12.0	34.0
Phalaris minor	0.0	4.7	3.7	6.7	3.7	18.7
Lolium temulentam	0.0	15.7	0.0	7.3	6.3	29.3
Total	5.7	25.7	15.3	14.0	22.0	82.8
Broad leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	**Total**
Fumaria officinalis	10.3	13.0	24.3	19.0	17. 7	84.3
Cardaria draba	7.3	9.0	7.7	11.7	12.7	48.3
***Rumex* spp.**	0.0	0.0	0.0	0.0	2.0	2.0
Brassica nigra	5.7	5.0	2.3	3.3	9.3	25.6
Vaccaria pyramedata	0.7	17.7	20.0	11.3	19.7	69.3
Melilotus officinalis	3.0	6.3	13.3	3.7	10.0	46.3
***Silene* spp.**	0.0	12.7	0.0	0.0	3.7	16.3
Silybum marianum	3.7	4.7	4.7	0.0	2.7	15.7
Carthamus oxyacanthus	0.0	0.0	0.0	0.0	0.0	0.0
Centaurea iberica	0.0	0.0	0.7	0.0	0.0	0.7
Convolvulus arvensis	3.7	17.3	11.7	17.7	1.7	52.0
Galium tinoctoria	0.0	9.3	2.3	1.7	3.3	16.6
Anagalis arvensis	0.0	10.0	3.0	1.67	5.7	20.3
Ranunculus arvensis	0.0	0.0	0.3	0.0	3.7	4.0
Polygonum aviculare	0.0	14.7	18.3	0.0	5.7	38.7
Capsella bursa-pastoris	0.0	0.0	0.0	0.0	1.3	1.3
Ammi majus	0.0	0.0	0.0	2.3	0.0	2.3
***Sonchus oleraceus* L.**	0.0	0.0	3.0	2.3	0.0	5.3
Matricaria chamomilla	3.7	0.0	0.0	0.7	0.0	4.3
***Malva parviflora* L.**	0.0	0.0	0.0	0.0	1.7	1.7
***Plantago lanceolata* L.**	0.0	0.0	0.0	0.0	2.0	2.0
Crepios cappilaris	0.0	0.0	0.0	0.0	0.0	0.0
Total	38.0	119.6	111.6	75.3	102.7	447.1

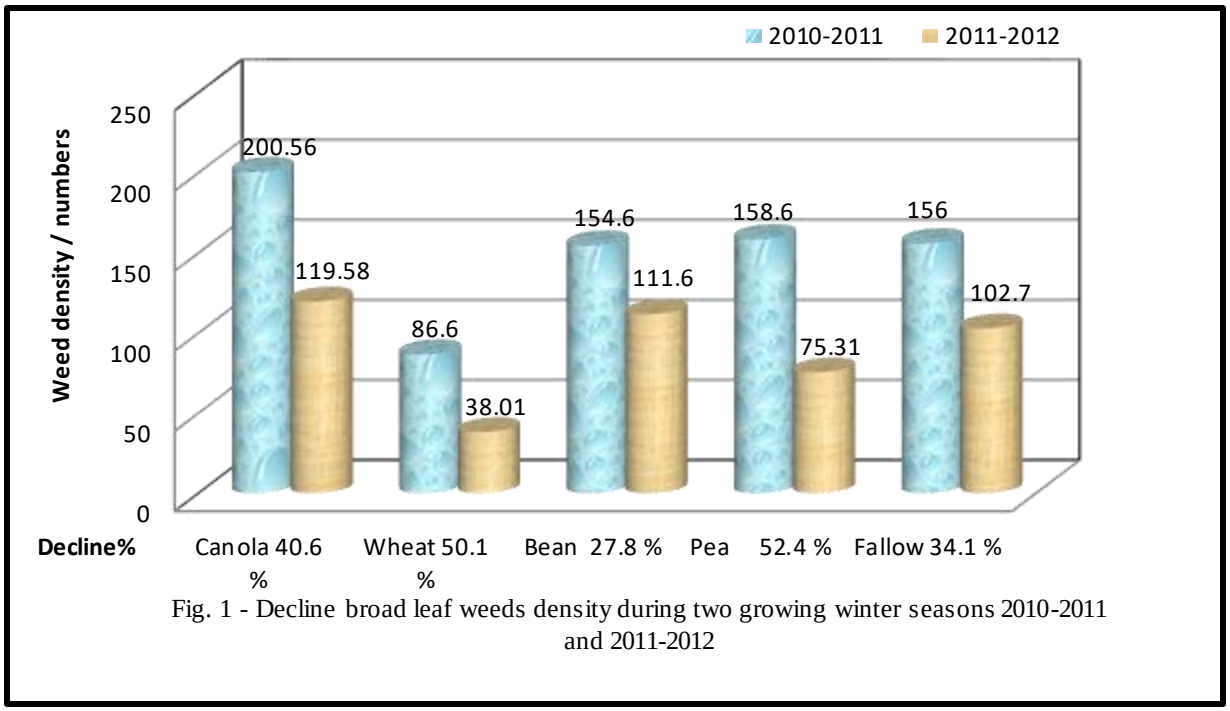

Fig. 1 - Decline broad leaf weeds density during two growing winter seasons 2010-2011 and 2011-2012

Figure-1: Decline broad leaf weeds density during two growing winter seasons 2010 – 2011 and 2011-2012.

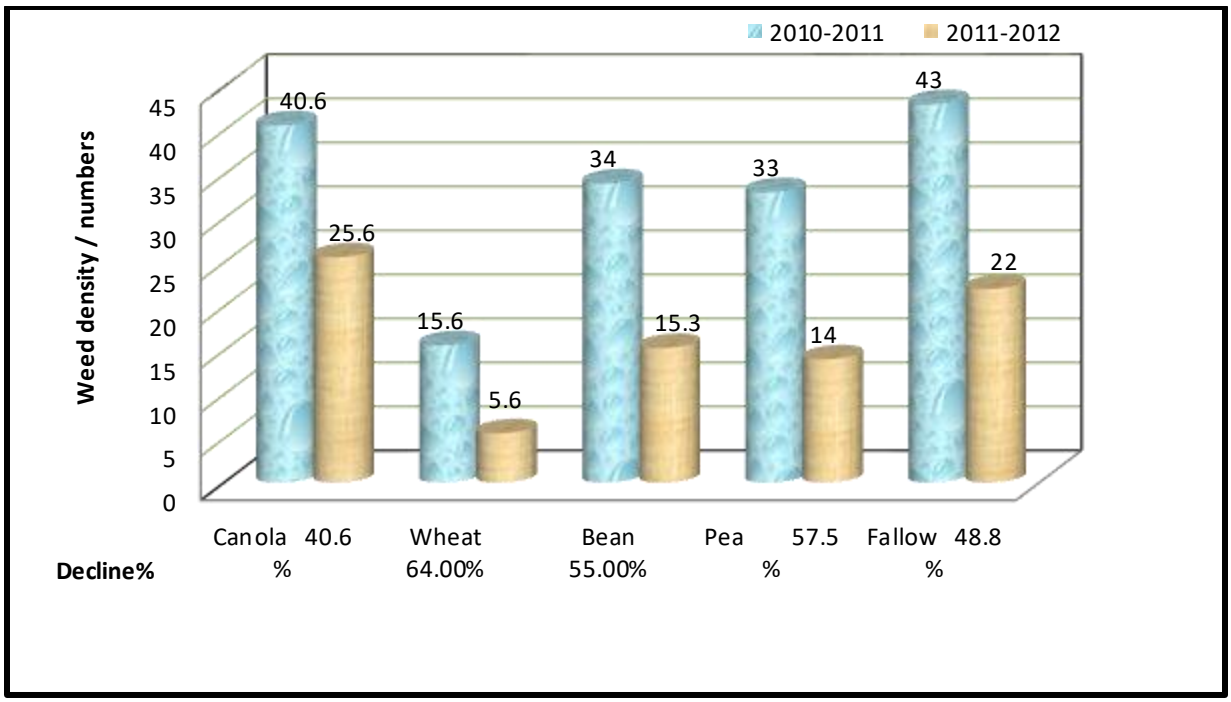

Figure-2: Decline in grass weeds density during two growing winter season 2010-2011 and 2011-2012.

Table 4. Number of weeds associated with maize crop during the first fall season 2011

The weeds	**No. of weeds/ plot at maize succession with winter crop**					
Narrow leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	**Total**
Echinochloa colonum	29.3	28.0	38.0	33.0	35.0	163.3
***Sorghum halepense* L. Pers.**	9.0	14.3	21.7	18.7	8.7	72.3
Total	38.3	42.3	59.8	51.7	43.8	235.7
Broad leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	**Total**
***Convolvulus arvensis* L.**	28.7	38.0	33.0	40.3	23.7	163.7
***Amaranthus* spp.**	0.0	15.0	8.7	6.7	2.3	53.3
***Portulaca oleracea* L.**	4.0	15.3	14.0	17.3	8.7	59.1
***Xanthium strumarium* L.**	0.0	2.0	1.0	0.0	0.0	3.0
***Heliotropium europaeum* L.**	0.0	2.0	0.7	0.0	0.0	2.7
***Chrozophoratinctoria* L. Raf.**	0.0	1.3	1.7	0.0	0.0	3.0
***Solanum nigrum* L.**	0.0	3.0	1.7	0.0	0.0	4.7
***Alhagi maurorum* Medik.**	0.0	0.3	0.3	0.0	0.0	0.6
***Prosopis farcta* (Banks & Sol.) J.F. Macbr.**	0.0	0.3	0.3	0.0	0.0	0.6
Total	32. 7	77.2	61.3	64.3	34.6	290.9

Table 5. Number of weeds associated with maize crop during the second fall season 2012

The weeds	**No. of weeds/ plot for planted crops**					**Total**
Narrow leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	
Echinochloa colonum	22.7	18.0	15.7	24.3	27.7	108.3
***Sorghum halepense* L. Pers.**	6.7	9.7	6.0	11.8	4.7	38.8
Total	29.3	27.7	21.7	35.1	32.3	147.1
Broad leaf weeds/Scientific name	**Wheat**	**Canola**	**Bean**	**Pea**	**Fallow**	**Total**
***Convolvulus arvensis* L.**	18.3	25.7	11.3	28.0	15.7	99.0
***Amaranthus* spp.**	0.0	0.0	0.0	1.7	0.0	1.7
***Portulaca oleracea* L.**	2.7	0.0	3.0	0.0	10.0	15.7
***Xanthium strumarium* L.**	0.0	0.0	0.0	0.0	0.0	0.0
***Heliotropium europaeum* L.**	0.0	0.0	0.0	0.0	0.0	0.0
***Chrozophora tinctoria* L. Raf.**	0.0	0.0	0.0	0.0	0.0	0.0
***Solanum nigrum* L.**	0.0	0.0	0.0	0.0	0.0	0.0
***Alhagi maurorum* Medik.**	0.0	0.67	0.0	0.0	0.0	0.7
***Prosopis farcta (Banks & Sol.)* J.F. Macbr.**	0.0	0.3	0.0	0.0	0.0	0.3
Total	21.0	26.7	14.3	29.7	25.7	117.3

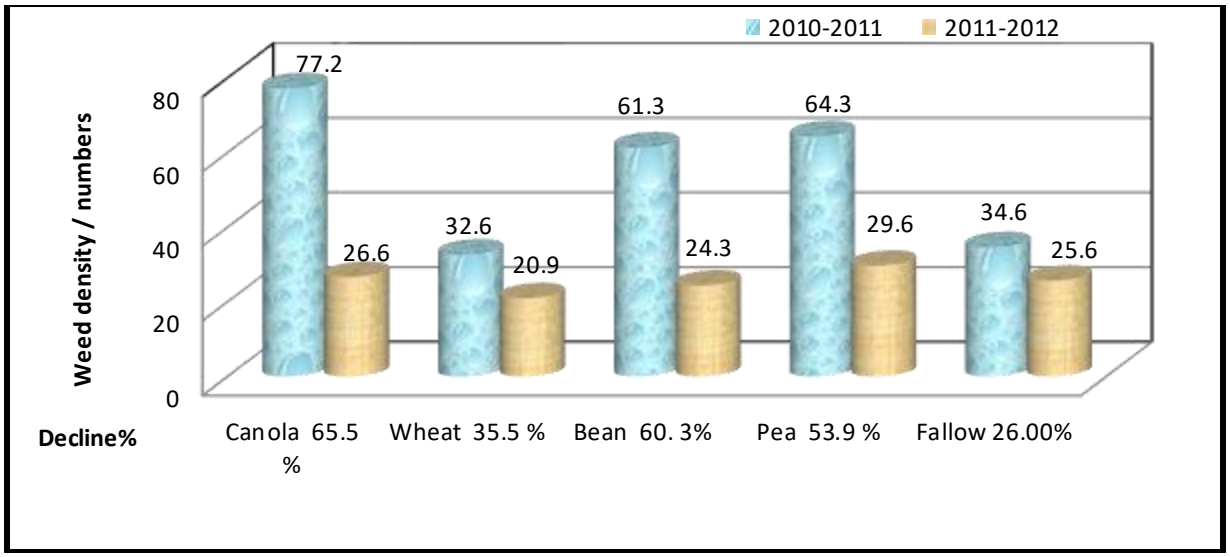

Figure-3: Decline broad leaf weeds density during two fall-seasons at maize plot 2011 and 2012

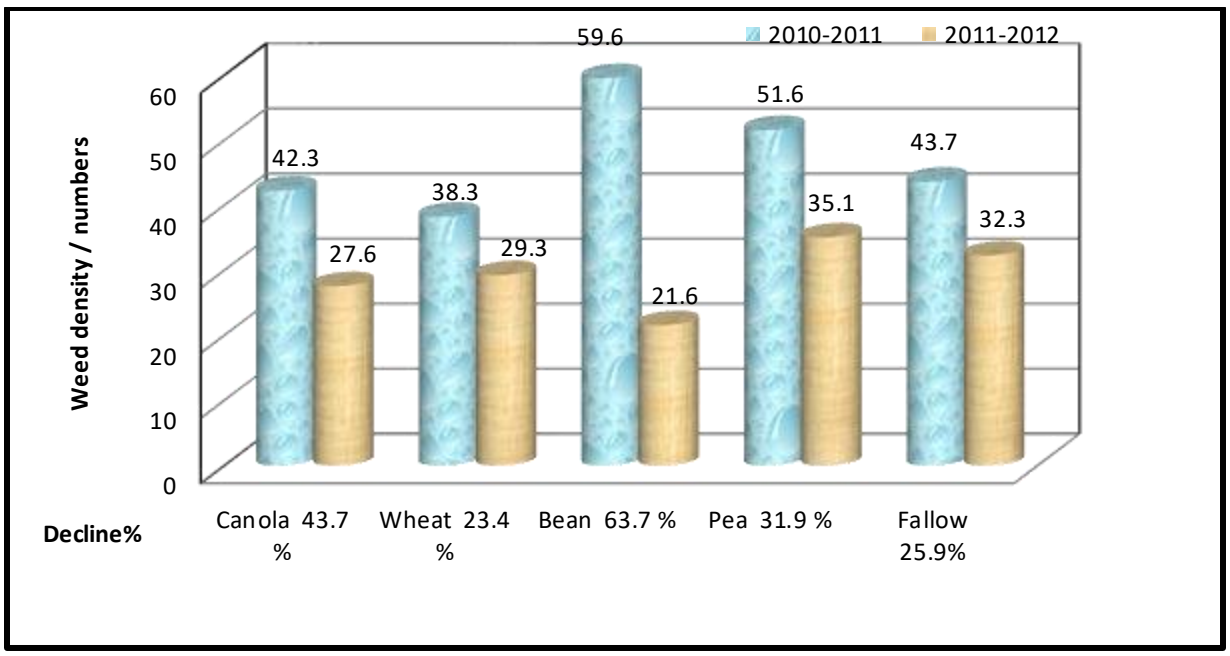

Figure-4: Decline of grass weeds density during two fall-seasons at maize 2011 and 2012.

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