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TOLERANCE OF CHICKPEA (*CICER ARIETINUM* L.) CULTIVARS TO THE MAJOR CHICKPEA HERBICIDES

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Abstract

Growing chickpea in sustainable systems requires the use and development of more adaptable genotypes which can adjust to the package of technology in vogue. Legumes are poor competitors with weeds. Hence repeated experiments were undertaken for quantifying the tolerance of chickpea cultivars with pre emergence herbicide pendimethalin 330E and post emergence herbicide fenoxaprop-p-ethyl 75 EW each at four doses. The chickpea varieties tested for tolerance were KC-98, Sheenghar, Lawaghir, KK-1, KK-2, SL-01-13, SL-02-13, SL-02-20, SL-02-22, SL-02-29, SL-03-29 and SL-04-29. Data were recorded on fresh and dry biomass of the germplasm. Sheenghar variety produced the best fresh weight (13.7 g) fol1owed by KC-98, Lawaghir and KK-1 (13.1, 12.24 and 13.0 g), respectively. Average effects of both the herbicides i.e. fenoxaprop-p-ethyl and pendimethalin were same on fresh biomass (11.37 and 11.39 kg ha^{-1}), respectively. Untreated and ½x dose produced statistically similar results for fresh biomass (12.53 and 12.8 kg ha^{-1}) respectively. While minimum fresh biomass was recorded at 1½X dose (8.8). 1X dose produced intermediate fresh weight (11.3). For dry biomass untreated check produced maximum (3.45 g) fol1owed by ½x dose (3.40 g) while, 1½X dose of either herbicide produced very low dry biomass (1.84 g). It is thus, concluded from the data that among the tested cultivars Sheenghar, Lawaghir, KC-98 and KK-1 and KK-2 have a reasonable tolerance to the two herbicides and these herbicides could be used at ½ and 1X doses without any adverse effect on the tested cultivars.

Introduction

Chickpea (*Cicer arietinum* L.) is a major food legume and an important source of protein in many countries in Asia and Africa. This species is the second most consumed and the third most cultivated grain legume (Dodak *et al*., 1993). Several studies are involved in the exploration of stress-resistant chickpea varieties (Anon., 2004). Dasht is a blight resistant variety of Desi chickpea with intermediate growth habit. It was released in the year 2002 for Pothowar and rice based areas. Dasht originated from a cross between C 44 and ICC 7770. C 44 is a local genotype well adapted to chickpea growing area of Punjab, whereas ICC 7770 is an *Ascochyta* blight resistant line obtained from ICRISAT, India (Ahmad *et al*., 2005). The major improvements in CMN-257 are manifested in the form of increase in seed size and erect plant type with stiff stem as compared to standards NIFA-88 and NIFA-95. The large seed size of CMN-257 is the main contributing factor towards increase in seed yield compared to NIFA-88 and NIFA-95 (Khattak *et al*., 2007; Shah *et al.*, 2010). Major producers of chickpea include India, Pakistan and Mexico (Badshah *et al*., 2003). In India and Pakistan, chickpeas are consumed locally and about 56% of the crop is retained by growers. Weeds are a serious constraint to increased production and easy harvesting in chickpea. Chickpea, however, is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stages of crop growth and establishment. Yield losses due to weed competition vary considerably depending on the level of weed infestation and weed species prevailing. Nevertheless, almost all values reflect the seriousness of the weed problem. Yield losses were observed to vary between 40 to 94% in the Indian subcontinent. Effective pre-planting and soil incorporated (PPI) herbicides include fluchloralin, oxyfluorfen, trifluralin and triallate. Those effective as pre-emergent herbicides are alachlor, chlorobromuron, cyanazine, dinoseb amine, methabenzthiazuron, metribuzin, pronamide, prometryne and terbutryne. Post-emergent herbicides include dinosebacetate, fluazifop-butyl and fenoxprop-ethyl. Post emergent applications need great care with respect to stage of growth and air temperature to avoid phytotoxicity (Bhan & Kukula, 1987).

Some crops are likely to be more amenable than others to the use of reduced herbicide doses. Kirkland *et al.* (2000) reported that good crop yields and the highest net returns could be attained with a 50% herbicide dose in barley but that a 100% herbicide dose was required to attain the highest yields and net returns in lentil (*Lens culinaris* L.).

The chickpea has been disseminated widely, and now ranks second among the world's food legumes in terms of area, being grown over 9.9 million ha on all continents except Antarctica (Anon., 2004). Chickpea cultivars were studied with various environmental concerns (Singh *et al*., 1987; Jain & Pandya 1988; Rao & Suryawanshi, 1988; Zubair & Ghafoor, 2001; Qureshi, 2001; Atta *et al.*, 2009). Hassan & Mueller-Warrant (1992) and Hassan *et al.*, 2002) quantified the tolerance among rice and ryegrass cultivars to fenoxaprop. Differential tolerance among the cultivars of both species was reported in the both species.

A. tenuifolius is very aggressive weed species prevailing in the sandy zone of Pakistan and competes with chickpea crop for the whole season. This weed species produced 45% average yield losses annually in sandy zone of Pakistan. To overcome problem, we investigated herbicides with recommended (1X), lower (½x) and higher (1½) doses on chickpea genotypes for their tolerance with the following objectives:

1. To investigate the most tolerant cultivar (s) of chickpea to herbicides.
2. To minimize injury of chickpea crop to herbicides.
3. To find out the most suitable herbicides dose applied in chickpea.

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Materials and Methods

Collection of seeds: Chickpea varieties, KC-98, Sheenghar, Lawaghir, KK-1, KK-2, SL-01-13, SL-02-13, SL-02-20, SL-02-22, SL-02-29, SL-03-29 and SL-04-29 were collected from Ahmad wala Research Station district Karak, Pakistan during August 2005. The seeds were cleaned and sun dried to minimize the risk of contamination. All the varieties were tested with pre and post emergence herbicide (pendimethalin and fenoxaprop-p-ethyl).

Seed germination: The experiment was undertaken in pots having 10 cm size, filled with sandy loam soil at the department of weed science, NWFP, Agricultural University Peshawar Pakistan during October 2005-06 and 2006-07. Initially, ten seeds were planted in each pot and after germination, the plants were thinned to 5 plants per pot.

Herbicides application: The herbicides pendimethalin 330E (pre emergence) and fenoxaprop-p-ethyl 75 EW (post emergence) were tested for tolerance of the above stated cultivars. The doses were 0, 0.41 (½x), 0.82 (1X) and 1.20 (1½X) and 0, 0.28, 0.56 and 0.90 kg a.i ha^{-1} respectively and were sprayed to each pot individually except the untreated check through knapsack sprayer having jet nozzle when the plants reached 10 cm in height. Two run of the experiment were undertaken in both the years in the same environmental conditions.

Statistical model and data analysis: The experiment was laid out in completely randomized (CR) design with factorial arrangements. Experiment was comprised of two replicates. Cultivars assigned to main plots, herbicides to sub plots and herbicides doses to sub- sub plots. Data were recorded on fresh and dry biomass of the chickpea cultivars after 4 weeks of herbicides application. GENSTAT computer software was used for data analysis and mean separation. The graphical presentation of data was made through MS Excel computer software.

Results

Fresh biomass (g): The fresh biomass of chickpea cultivars and herbicides averaged across runs and doses were differentially affected by herbicides ($p<0.001$). Fig. 1 indicated that the main effects of cultivars showed that maximum (13.32 and 13.17 g) fresh biomass was produced by Sheenghar and KC-98 varieties respectively. While minimum (10.31 g) fresh biomass was produced by SL-03-29 however, it was statistically at par with SL-02-29, SL-04-29, SL-02-22, SL-02-20, SL-01-13, SL-02-13.The interaction with significantly higher fresh weight was observed in KC-98 and Sheenghar cultivars (14.4 and 14.1) respectively. Minimum fresh biomass in interaction was recorded for SL-03-29 (9.29).

Herbicides and dose interaction averaged across years and cultivars differentially ($p<0.001$) affected the fresh weight of chickpea cultivars. Fig. 2 exhibited that the main effects of doses revealed that maximum (15.4 g) fresh biomass was observed at untreated check followed by ½x and 1X (12.8 and 11.36 g) respectively. Minimum (8.81 g) fresh biomass was recorded at 1½X. In the interaction of herbicides and doses fenoxaprop-p-ethyl differentially increased the fresh weight (9.0) at 1½X as compared to pendimethalin at the same dose (8.6). While at ½x and 1X doses both herbicides produced statistically similar fresh biomass.

Dry biomass (g): Cultivars, herbicides and their interaction had significantly affected the dry biomass of chickpea cultivars $p<0.001$ (Fig. 3). The data indicated that the main effects of cultivars showed that maximum (4.55 g) dry biomass was recorded for KC-98 variety of chickpea followed by Sheenghar variety (3.68 g), while all other cultivars produced moderate dry biomass. The minimum (2.26 g) dry biomass was produced by SL-02-22 however, it was statistically at par with SL-02-29, SL-04-29, SL-02-22, SL-02-20, SL-01-13, SL-02-13. The data further indicated the nature of this interaction with significantly higher dry weight observed for KC-98 (4.5 and 4.6) at both fenoxaprop-p-ethyl and pendimethalin respectively followed by Sheenghar variety (4.11 g) at fenoxaprop-p-ethyl. Minimum dry weight was observed for SL-02-22 (2.2). However, it was statistically not different to SL-02-22, SL-04-29, SL02-20, SL-01-13.

Herbicides, doses, and their interactions significantly affected the dry weight of chickpea cultivars (Fig. 4). The data indicated that the main effects of herbicides doses showed that maximum (3.45 and 3.40 g) dry biomass was recorded for untreated and ½x doses respectively followed by 1X dose (3.04 g). While minimum (1.8 g) dry biomass was observed at 1½X dose. The data further indicated that dry weight decreased at 1½X dose (1.8) each in both the herbicides tested. Maximum dry weight was recorded at untreated check (3.5) in fenoxaprop-p-ethyl treatment however, it was statistically similar to the ½x dose in the same herbicides treatment. 1X dose produced statistically similar results in both the herbicides.

The three way interaction of cultivars x herbicides x doses significantly affected the dry biomass of chickpea cultivars (Figs. 5 and 6). The data indicated that the main effects of cultivars showed that maximum (5.5 g) dry biomass was recorded for KC-98 variety of chickpea followed by Sheenghar variety (4.68 g). While minimum (2.26 g) dry biomass was produced by SL-02-22 however, it was statistically at par with SL-02-29, SL-04-29, SL-02-22, SL-02-20, SL-01-13 and SL-02-13. Among the herbicide doses maximum (3.45 and 3.40 g) dry biomass was recorded for untreated and ½x doses respectively followed by 1X dose (3.04 g). While minimum (1.8 g) dry biomass was observed at 1½X dose. The interaction showed that maximum dry biomass was recorded for KC-98 at ½x dose in both the pre and post emergence herbicide (5.9 and 5.5 g) respectively. Sheenghar cultivar produces (5.0 g) dry biomass at ½x dose in fenoxaprop-p-ethyl herbicide. Minimum dry weight was recorded for SL-02-22 and SL-02-20 (1.2 and 1.0 g) under fenoaprop-p-ethyl, respectively.

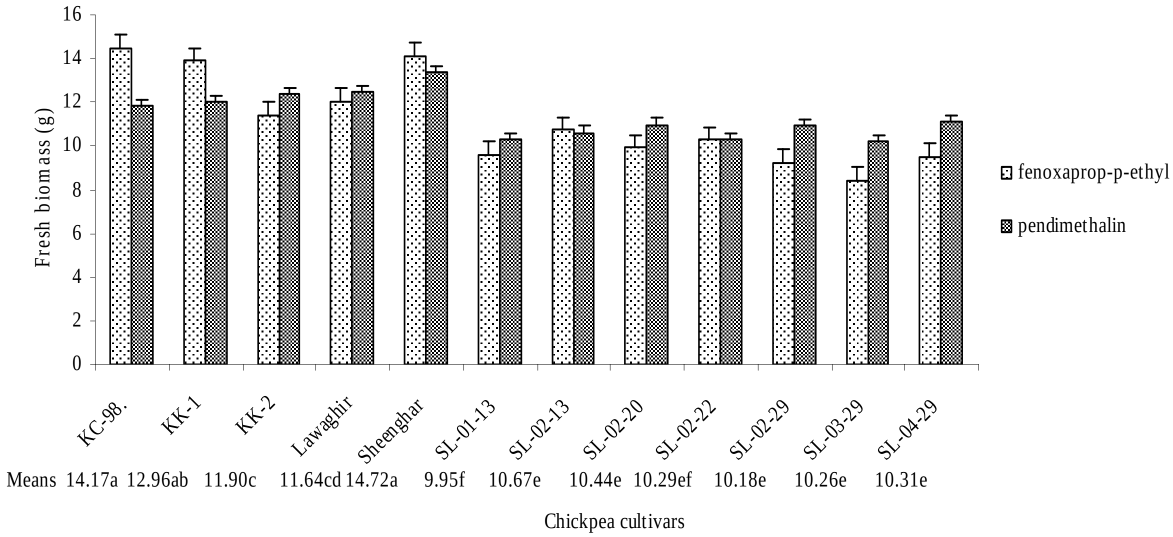


Fig. 1. Fresh biomass as affected by chickpea cultivars and herbicides.

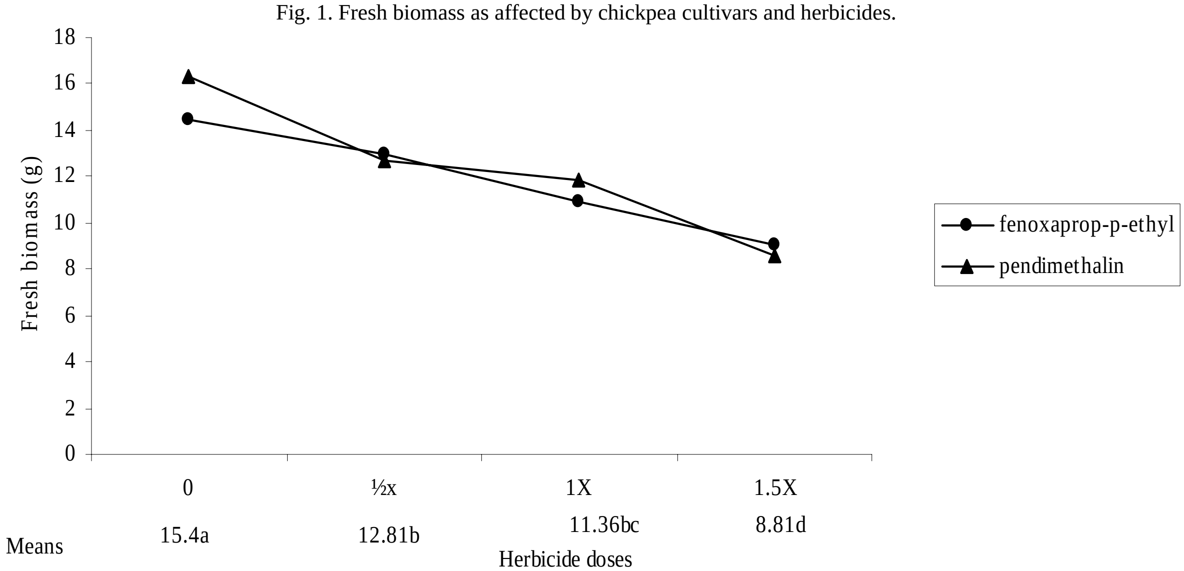


Fig. 2. Fresh biomass of chickpea as affected by herbicides and doses.

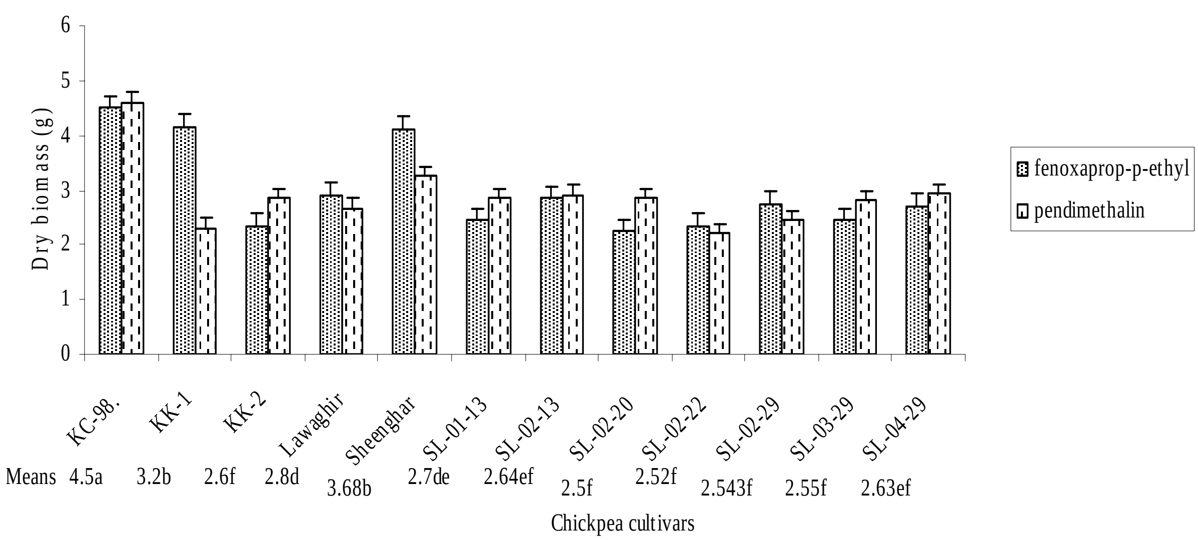


Fig. 3. Dry biomass as affected by chickpea cultivars and herbicides.

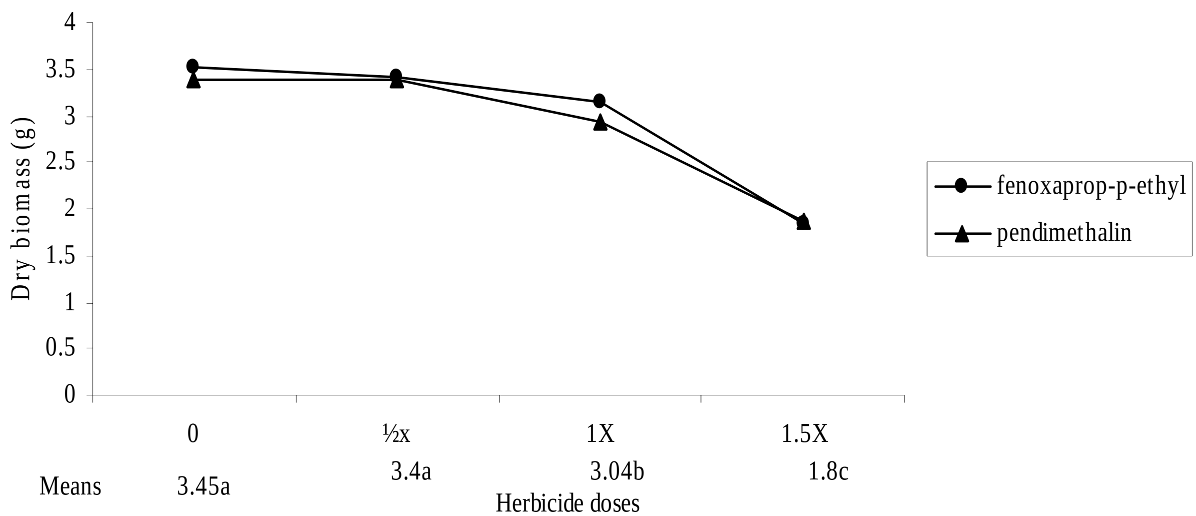
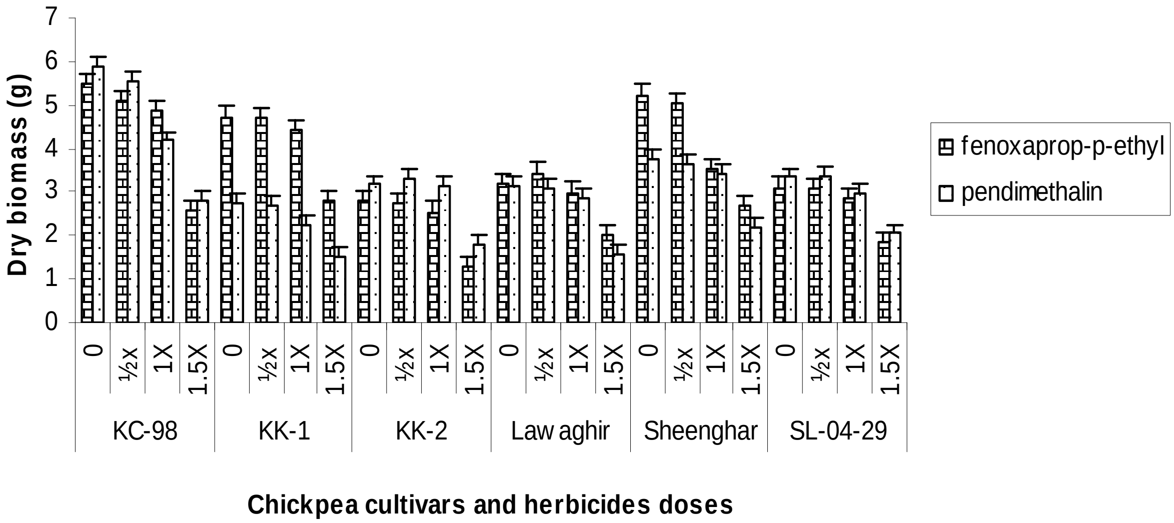
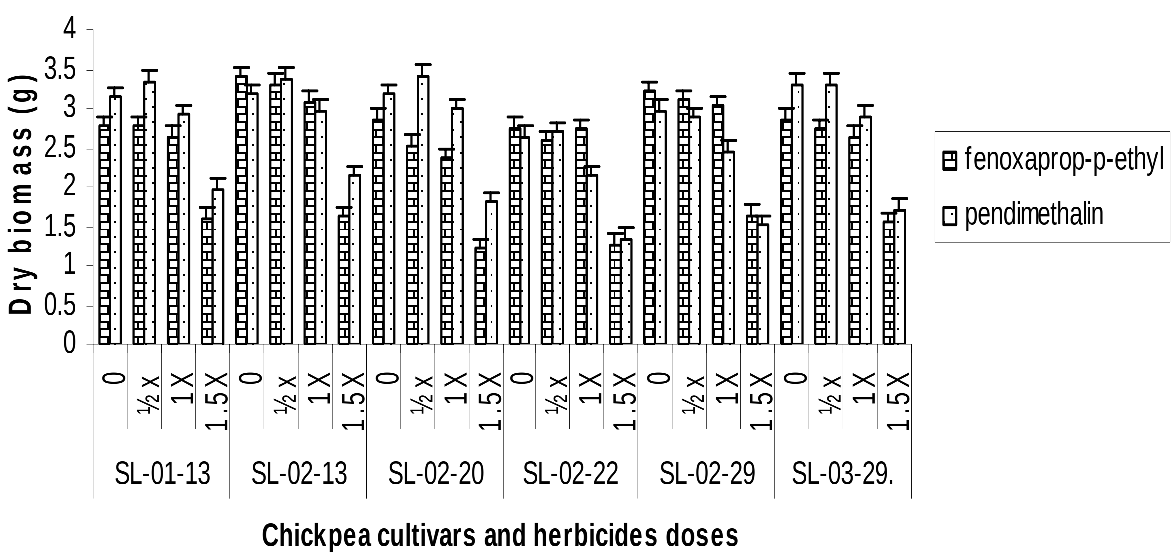


Fig. 4. Dry biomass of chickpea as affected by herbicides and doses.



A

Fig. 5. Dry biomass of chickpea cultivars as affected by herbicides and their doses.



B

Fig. 6. Dry biomass of chickpea cultivars as affected by herbicides and their doses.

Discussion

For elucidating the tolerance of different chickpea genotypes to herbicides, the instant studies were undertaken on 12 varieties of chickpea. Two varieties (KC-98 and Sheenghar) showed maximum tolerance to both the herbicides while the remaining varieties were susceptible. It was postulated that ½x dose of herbicides produced adequate results as compared to the 1½X or 1X dose in case of legumes. Kudsk & Streibig (1993) recommended ½x doses for keeping good stands of plants, pollution free environment and other human health hazards. The response of both the herbicidal treatments to chickpea genotypes were not differential ($p<0.84$) regarding fresh weight. Several studies were conducted on reduced herbicide doses regarding chickpea crop. The results of Seefeldt *et al*., (1995); Kudsk & Mathiassen (2007) showed that herbicides were the most effective tools for maximizing agronomic parameters in field crops by reducing weeds infestation. Malik *et al*., (2003) also reported that herbicides decreased the dry weight significantly. These results are also in a great analogy with the work of Iqbal *et al*., (1991) and Poonia *et al*., (1993) who were also of the view that herbicides decreased the weed dry weight significantly. These results indicated that post emergent application of fenoxaprop-p-ethyl should be the best choice at ½x dose and 1X dose, while recommended and 1½X dose of pendimethaline will be effective as pre emergence. Johnson *et al*. (2002) reported similar results on herbicides doses and growth relationship of the crops. Our findings are also in a great conformity with those reported by Covarelli & Pannacci (2000) who reported that herbicides with ½x dose are the best tools for weed control depending on species and situations. During the course of experiment pre emergence herbicide doses 1X and 1½X produced best results. While the post emergence herbicide ½x and 1X dose produced best results as compared to 1½X dose. The 1½X dose of post emergence herbicides showed phytotoxic effects on crops and reduced the fresh and dry biomass of chickpea.

Conclusions

Tolerance of few chickpea varieties like Sheenghar, Lawaghir, KC-98, KK-1 and KK-2 was more satisfactory to both the pre and post emergence herbicides at 1X and ½x dose, while all remaining varieties were susceptible to both the herbicides at 1½X dose of herbicides. The research findings will increase farmers' awareness regarding chickpea tolerance to the above herbicides and provide guidelines for adjustment of rates for minimizing crop injury.

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