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EFFECTS OF WEED CROP COMPETITION PERIOD ON WEEDS AND YIELD AND YIELD COMPONENTS OF SESAME (*Sesamum indicum* L.)

Zubair Ijlal[1], Asif Tanveer[1], Muhammad Ehsan Safdar[2], Ahsan Aziz[2], Muhammad Ashraf[2], Naeem Akhtar[2], Farhan A. Atif[2], Asghar Ali[2] and Muhammad Mudassar Maqbool[3]

ABSTRACT

Farmers' efforts to control Sesame (Sesamum indicum L.) weeds provide low economic returns as the information regarding critical weed-crop competition period is lacking. We investigated the critical weed-crop competition period in sesame at the Agronomic Research Area, University of Agriculture, Faisalabad Pakistan during summer season (July-November) 2005. Treatments were weed-crop competition periods (WCCP) of 3, 4, 5, 6 and 7 weeks after emergence in addition to full season competition and full season weedy check as negative and positive controls, respectively. A gradual decrease from 6.88 to 12.40 % in seed yield was recorded with 6 weeks to full season weed-crop competition. Non significant reduction in seed yield was observed up to 5 weeks WCCP. Weed crop competition for a period of 3 weeks did not show significant decrease in straw yield, number of capsules plant^{-1}, number of seeds capsule^{-1} and 1000 seed weight, whereas a significant decline in all these parameters was noted as WCCP exceeded 3 weeks. Weed density and dry weight did not increase significantly until WCCP was prolonged up to 3 and 4 weeks, respectively. This study led to conclude that although growth decline was started after 3rd week, however significant yield decline was noticed from 6th week after crop emergence.

Key Words: Yield, weeds, competition period, *Sesamum indicum* L.

INTRODUCTION

Pakistan is annually spending Rs.77.78 billion on the import of edible oil, as only 24 % of total edible oil requirements are fulfilled through local production (GOP, 2010). According to growth habit, oil seed crops are grouped into annuals, which include soybean, sunflower, rapeseed, groundnut, sesame, safflower, cotton and corn; and perennials which include oil palms, coconut and olives (Americanos, 1994). In Pakistan, oilseed crops are classified into conventional and non-conventional ones. Rapeseed, mustards, sesame and groundnut are considered to be conventional whereas sunflower,

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[1]Department of Agronomy, University of Agriculture, Faisalabad-38040, Pakistan
[2]University College of Agriculture, University of Sargodha, Sargodha-40100, Pakistan E-mail: drahsanaziz@gmail.com
[3]DG Khan Agriculture College, University of Agriculture, Faisalabad, Pakistan

soybean and safflower are categorized as non-conventional oilseeds. Efforts have been made to increase indigenous oil production through promoting the cultivation of non-conventional oilseed crops but still the gap between demand and local production has not been bridged. Therefore, there is dire need to increase per hectare yield of conventional oil seed crops. Sesame is well adapted to grow successfully under tropical to temperate conditions and it had been cultivated in subcontinent since 2000 B.C. (Vats, 1940). Sesame oil contains sesamoline and sesamine, which are used as synergists for insecticides (Ryu *et al.*, 1992). Due to presence of these compounds, its oil is resistant to rancidity hence sesame is known as the 'queen of oilseeds' (Namiki, 1995). In addition, its oil is also rich in protein (22%) and its seed meal contains 42% protein (Khan and Sheikh, 1985).

Weed infestation is one of the major factors limiting the yield of sesame as its seedling growth is slow during the first four weeks making it a poor competitor at earlier stages of crop growth (Nazir, 1994; Bennett *et al.*, 2003). Therefore, insufficient weed control during early growth period of sesame may cause yield reduction between 35 to 70% (Dharma *et al.,* 1992). So, the presence of weeds at critical period for weed control (CPWC) leads to serious yield losses (Weaver and Tan, 1983; Weaver *et al.,* 1992; Knezevic *et al.*, 2002). Review of literature revealed that critical weed crop competition period varied considerably with the nature and status of crop, weed flora composition, extent of weed infestation and the prevailing environment (Zimdahl, 2004; Weaver *et al.*, 1992; Knezevic *et al.*, 2002). For instance, the critical period for weed competition in sesame is 60 days after seedling emergence (DAE) in Sausa and 30-35 DAE in Monteiro, Brazil (Beltrao *et al.*, 1997) and 30-45 days after sowing in India (Venkatakrishnan and Gnanmurthy, 1998). Amare *et al.* (2009) found a critical period of weed competition in sesame crop between 10 and 30 days after seedling emergence. Similarly, CPWCs in maize as reported by different investigators were 2 to 3 weeks after crop emergence at Mexico (Nieto *et al.*, 1968), 4 weeks after seeding (Gleason, 1956; Bunting and Ludwig, 1964), 3 to 6 weeks after sowing (Zimdahl, 2004) and 0.2 to 5.2 weeks after crop emergence in Turkey (Isik *et al.*, 2006). In other oilseed crops, the critical period for weed competition varied a lot depending upon crop duration, e.g. in case of Soybean, if the crop is not kept weed free up to 4 weeks after sowing, competition for photosynthetically active radiation (PAR) takes place due to over-shading of weeds over the crop (Jannink *et al.,* 2000). Keeping in view the importance of well defined CPWC, we investigated the critical weed crop competition period in sesame under arid to semi-arid climatic conditions of Faisalabad, Pakistan.

MATERIALS AND METHODS

Field studies were conducted at the Agronomic Research Farm, University of Agriculture, Faisalabad, Pakistan during 2005 to find out the critical weed-crop competition period in sesame by subjecting the crop to various weed competition periods and then evaluating their effect on weed density and biomass, and sesame growth and yield. The experiment comprised of four weed crop competition periods *viz.,* 3, 4, 5, 6 and 7 weeks weed competition after crop emergence in addition to full crop season weed competition and full season weed free condition, kept as negative and positive controls, respectively. Weed free conditions during rest of growing season in respective treatments and whole growing period were maintained by hand hoeing using 'kasula' and 'khurpa' (local tools), while in case of full season competition no weed control was employed. Experiment was laid out in randomized complete block design (RCBD) with three replications. Net plot size was 1.8 m x 5.0 m. Sesame variety TS-3 was used as a test crop. Crop was sown in the month of July with a single row hand drill using a seed rate of 5 kg ha^{-1} at row-to-row distance of 45 cm. Plant to plant distance of 10 cm was maintained by thinning after 15 to 19 days of crop emergence. Nitrogen and phosphorus at the rate of 30 and 23 kg ha^{-1} were applied in the form of urea and di-ammonium phosphate (DAP), respectively. Half of nitrogen and full dose of phosphorus was applied as basal application while remaining half of nitrogen was top dressed at the time of 2nd irrigation. *Trianthema portulocastrum* (horse purslane vern. itsit), *Echinocloa colonum* (jungle rice vern. swanki), *Cyperus rotundus* (purple nutsedge vern. deela) and *Cynodon dactylon* (bermudagrass vern. khabbal) were the predominant weed species. Weed density m^{-2} and biomass in each treatment were taken by counting and uprooting weeds from an area of one square meter from two randomly selected places at the time of completion of their respective competition periods and their fresh and dry weights were determined. The means of these two were calculated by taking their averages. Dry weight of weeds was taken by drying weeds in an electric oven at 80 $^{\circ}$C temperature till their constant weights were achieved. Crop parameters like number of plants plot^{-1}, plant height, number of capsules plant^{-1}, number of seeds capsule^{-1}, 1000 seed weight, biological yield, seed yield and straw yield were taken at crop maturity. Straw yield was calculated by subtracting seed yield from biological yield. All the data collected were subjected to statistical analysis using Fisher's analysis of variance technique and the treatment means were compared by least significance difference (LSD) test at 5% probability level (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Weed density m^{-2}

Data pertaining to the effect of different weed crop competition periods on weed density m^{-2} (Table-1) show that there were significant differences among all the treatments studied. The number of weeds gradually increased as the duration of weed crop association increased. Maximum number of weeds m^{-2} (34.67) were counted in plots where weeds were allowed to compete with crop for full growing season which was significantly different from all other treatments. On the other hand, minimum weed population m^{-2} (13.67) was observed in competition period for 3 weeks after emergence (WAE). Increase in weed population with prolonged competition period might be due to the extra time availed by weeds to germinate and continue their growth. These results are in line with those of Zafar *et al.,* (2010) who reported that there was an increase in weed population and biomass with an increase in weed-crop competition period.

Likewise Singh *et al.,* (1992), Sootrakar *et al.,* (1995) and Bennett (2003) also reported that weed control for the first 28 to 55 days after sowing resulted in the reduced weed count at maturity as seedling growth was slow in this crop during initial growth stages making it to be a poorer competitor than weeds.

Weed dry weight m^{-2} (g)

Effect of WCCP on weed dry weight is presented in Table-1 which shows that as we increased number of weeks for weed competition weed dry weight also increased. Full season WCCP produced highest weed dry weight (134.67 g) which was non-significantly different from that recorded in 6 and 7 weeks WCCPs giving 139.8 g m^{-2} and 137.9 g m^{-2} weed dry weights, respectively. Among all the other competition periods, 3 weeks WCCP gave minimum (30.63 g m^{-2}) weed dry weight. Increase in dry weight of weeds was due to increase in fresh weight of weeds as a result of prolonged weed growth. Theses results are in conformity with those of Bennett (1993) who identified that critical period of weed competition in sesame lies between 15 to 45 days after sowing which resulted in maximum weed biomass.

Number of sesame plants $plot^{-1}$

Non-significant differences were observed among treatments for sesame plant population (Table-1). The sesame plant population remained unaffected by weed competition periods. This was probably due to maintenance of uniform plant population through thinning just after crop emergence.

Sesame plant height (cm)

The plant height is a function of both genetic and environmental factors. Comparison of plant heights among various treatments is given in Table-1 which shows that plant height decreased significantly with the increase in WCCP. The tallest plants (125.4 m) were observed in zero competition which did not reduce significantly in 3 weeks (125.9 cm) and 4 weeks (125.4 cm) WCCP, whereas minimum plant height (117.1 cm) was observed in full season weed competition. Competition between sesame and weeds beyond 4 WAE suppressed crop growth which was manifested in the form of reduced plant height.

Comparison of plant heights among various treatments is given in Table-1 which shows that sesame plant height remained unaffected from 0 to 4 weeks WCCP but a significant decrease in plant height was recorded when WCCP was extended beyond 4 weeks. Plant height was minimum (117.1 cm) in full season weed competition. Langham *et al.* (2009) found that sesame initially showed a very slow growth but after 30 days, it grew as fastly as overshading almost all weeds. Therefore weed competition during this period significantly reduced sesame plant height. The similar findings in maize and cotton had also been reported by Martinkova and Honken (2001) and Askew and Wiltcut (2001).

Table-1. Effect of WCCP on parameters related to weed and crop growth.

WCCP	Weed population m^{-2}	Weed dry weight m^{-2} (g)	Number of sesame plants 9.0 m^{-2}	Sesame Plant height (cm)
Zero competition	0 g	0 d	203.33	125.4 a
3 weeks competition	13.67 f	30.63 cd	202.67	125.9 a
4 weeks competition	18.00 e	42.97 c	202.67	125.4 a
5 weeks competition	20.00 d	81.43 b	201.00	121.8 b
6 weeks competition	25.33 c	139.8 a	202.67	120.2 bc
7 weeks competition	30.67 b	137.9 a	202.33	117.9 cd
Full season competition	34.67 a	134.67 a	200.00	117.0 d
LSD	**1.77**	**35.68**	**NS**	**2.32**

Any two means in a column not sharing a letter in common are significantly different at 5 % probability level.

Number of capsules plant^{-1}

Number of capsules plant^{-1} is an important parameter contributing towards the final grain yield. The regression analysis presented in Fig. 1 indicated that number of capsules plant^{-1} had a strong significant negative relationship (R^2 = 0.948) with duration of weed competition. The highest numbers of capsules plant^{-1} were produced in plots where crop was kept weed free throughout growing season (zero competition). It remained statistically at par with that recorded in plots where weed competition was employed for a period of 3 WAE. A successive decrease in number of capsules plant^{-1} can be observed as WCCP prolonged until it encompassed whole of the crop growing season in which minimum number of capsules plant^{-1} (52.17) were noted. Maximum number of capsules plant^{-1} in zero competition was due to superior photosynthetic efficiency of crop plants supported by the ample availability of water, nutrients and radiation in the absence of weeds. This elevated level of photo-assimilates sustained the development of more number of capsules plant^{-1}. These results are in line with those of Serogy (1992).

Number of seeds capsule^{-1}

An important yield component which reflects production potential of individual capsule of sesame plant is the number of seeds capsule^{-1}. Number of seeds capsule^{-1} also showed a significant negative relationship (R^2 = 0.966) with weed competition period (Fig-2). A declining trend with increase in the period of weed competition can be observed. However, non-significant reduction in number of seeds capsule^{-1} from zero competition (54.93) up to 3 weeks WCCP (53.23) was observed. Beyond which it decreased significantly reaching to a minimum value of 38.97 seeds capsule^{-1} in full season competition. Maximum number of seeds per capsule in zero competition was due to better plant growth and resultant enhanced development of capsules in absence of weeds. These results are supported by those of Pascua (1988) who reported that in mungbean the number of seeds per pod were higher in plots that gave lower weed fresh weight.

1000 seed weight (g)

Seed weight reflects the capacity of a crop plant to transport its photosynthetic assimilates to economically valuable parts. Regression analysis of 1000 seed weight with duration of weed competition are presented in Fig. 3 which revealed that duration of weed competition significantly influenced seed weight (R^2 = 0.865). The highest 1000 seed weight (3.92 g) was achieved in positive control which was statistically non-significant with that recorded in 3 weeks WCCP (3.77 g). Weed competition up to full season resulted in lowest 1000 seed weight (3.16 g). It appears to be quite logical that weed free control crop made full utilization of the environmental resources. The removal of weeds at early crop growth stages helped plants to make full use of growth factors without facing any competition effect. These results are in agreement with those of Spader and Vidal (2000) who noted decrease in grain weights of maize with an increase in weed density.

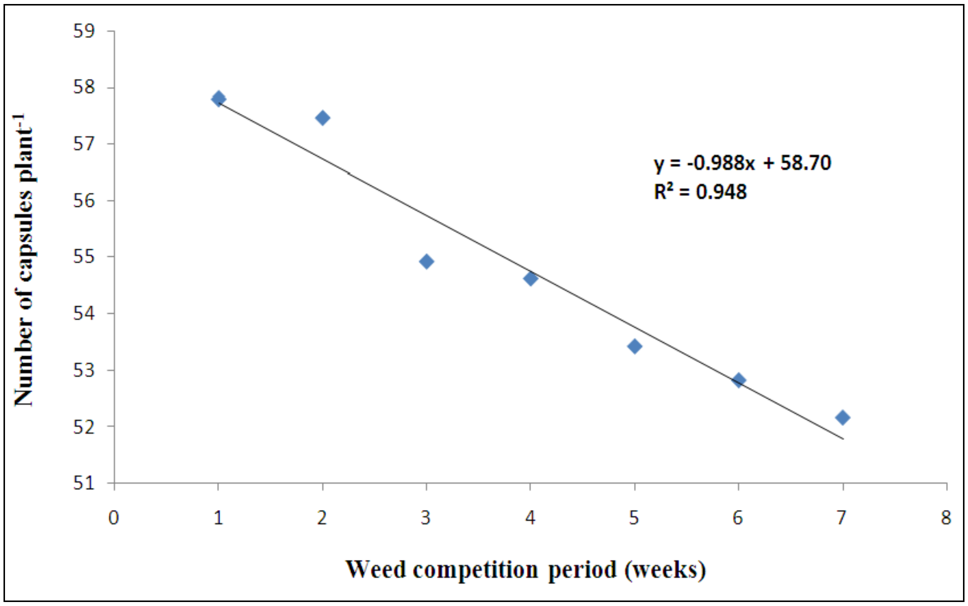

Figure 1. Number of capsules plant^{-1} of sesame as affected by weed competition period.

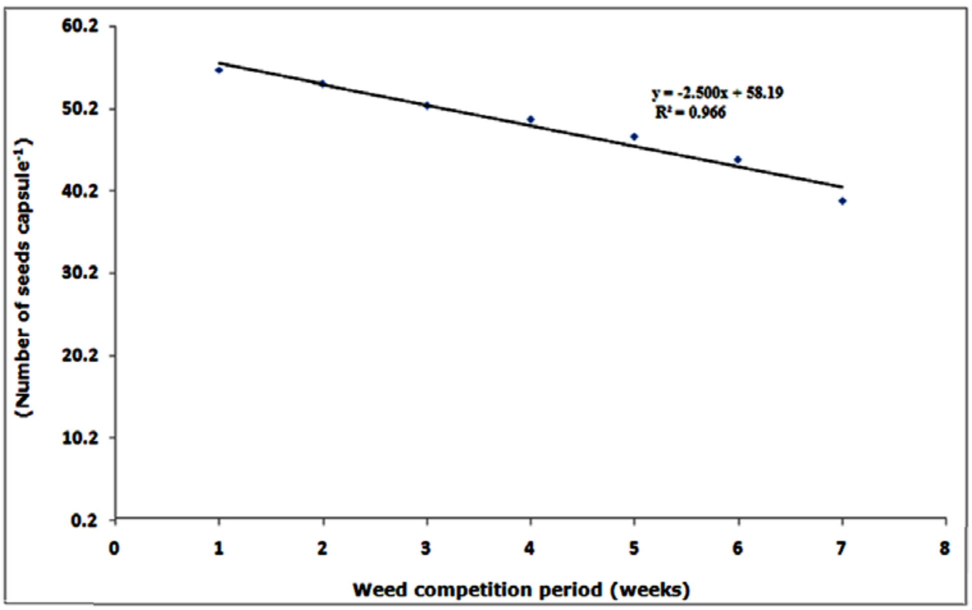

Figure 2. Number of seeds capsules $^{-1}$ of sesame as affected by weed competition period.

Biological yield (kg ha^{-1})

Biological yield is the total biomass of the above ground plant parts including economic and uneconomic portions of a crop. It represents the total dry matter accumulation capacity of a crop and is a combination of its vegetative and reproductive parts Statistical analysis of the data on biological yield (Fig. 4) revealed that treatment means differ significantly among various weed competition periods. The highest value of biological yield (2944 kg ha^{-1}) was attained when crop was kept free from weeds throughout its growth. However it did not differ significantly from plots having weedy conditions up to 3 WAE. Then a progressive decrease in sesame biomass was noted as we started weeding after 4, 5, 6 and 7 WAE, ultimately reaching to its lowest value (2547 kg ha^{-1}) under no weeding. The highest biological yield obtained in plots subjected to no weed competition was due to better plant growth and biomass production under weed free conditions. These results are supported by the findings of Muhammad and Ahmad (1999) who got minimum biological yield from those plots where weed competition was prolonged up to 50 days after emergence in mungbean.

Straw yield (kg ha^{-1})

Comparison of straw yields obtained in various WCCPs as depicted in Fig. 4 show that duration of weed competition periods casted a significant effect on this parameter. Full season weed free conditions gave the maximum value (2617 kg ha^{-1}) of straw yield which was statistically at par with that recorded in 3 weeks WCCP (2581 kg ha^{-1}). However, the minimum straw yield (2231 kg ha^{-1}) was achieved when weedy conditions were kept throughout the growing season of crop. Weed free crop for prolonged growing period gained higher straw yield on account of higher plant height and number of capsules per plant. These results are in close conformity with those of Bayan and Saharia (1998) and Martinkova and Honek (2001) who found decreased plant dry matter with increased weed competition period in green gram and maize, respectively.

Seed yield (kg ha^{-1})

Seed yield, the ultimate goal of growers, is a function of the integrated effect of all the yield components. Data regarding the effect of WCCP on seed yield are shown in Fig. 5 which clearly indicates seed yield to be significantly affected by duration of weed competition. The highest seed yield (363 kg ha^{-1}) was produced in full season weed free conditions and it was statistically at par with the seed yields obtained in 3, 4, and 5 weeks weedy conditions. As we extended the weed competition period, seed yield gradually declined up to a lowest value of 318 kg ha^{-1} in full season weedy conditions. A 12.4 % reduction in seed yield occurred while going from full season weed free conditions to full season weedy conditions. Seed yields in prolonged weed free crop growth remained higher due to higher number of capsules per plant, number of seeds per capsule and 1000 seed weight. Serogy (1992), Zewdie (1996), Shamna and Mishra (1997), Narkhede *et al.* (2000) and Amare *et al.* (2009) reported a higher seed yield in sesame under prolonged weed free conditions after crop emergence.

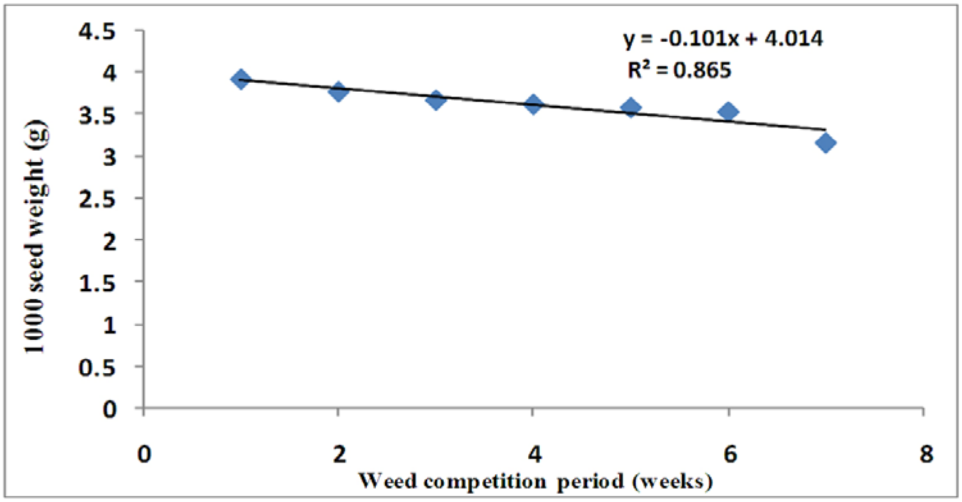

Figure 3. 1000 seed weight (g) of sesame as affected by weed competition period.

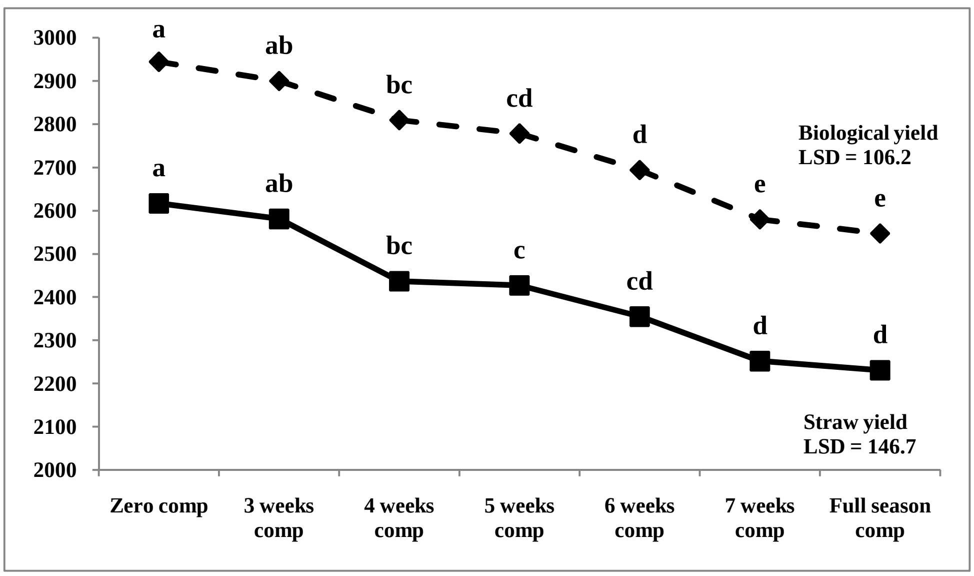

Figure 4. Biological yield (kg ha^{-1}) and straw yield (kg ha^{-1}) of sesame crop as affected by weed crop competition period.

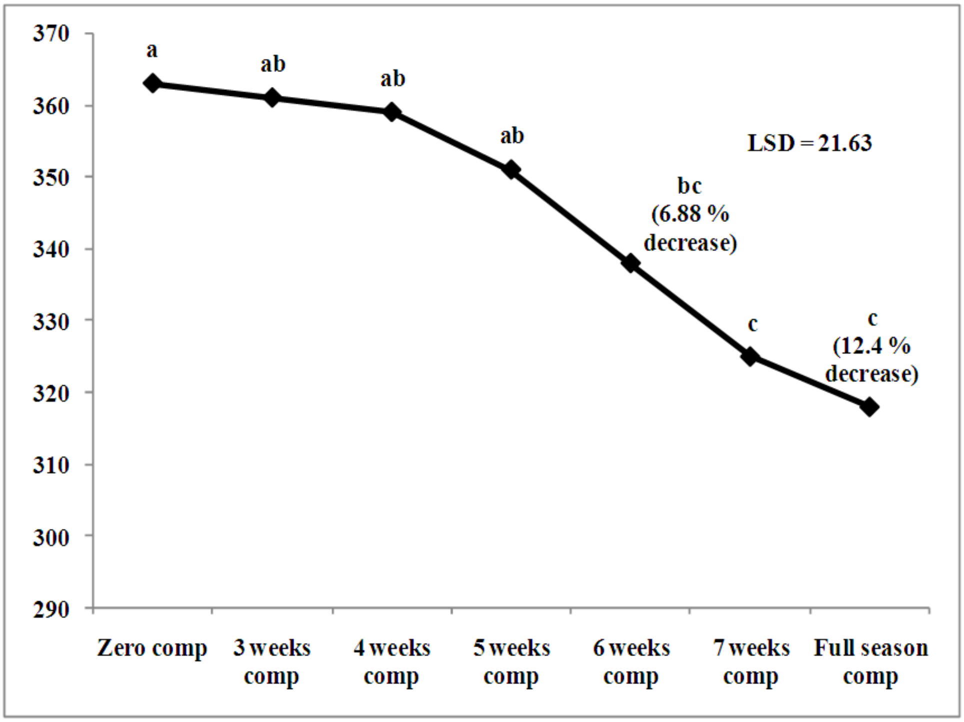

Figure 5. Seed yield (kg ha^{-1}) of sesame crop as affected by weed competition period.

REFERENCES CITED

Amare, M., G. Woldewahid and J.J. Sharma. 2009. Sesame crops versus weeds: when is the critical period of weed control? Proc. African Crop Sci. Conf. 9, pp. 591–593.

Americanos, P.G. 1994. Weed Management in oil Crops. Pages 331-338. *In* FAO Plant Protection Paper, FAO Rome, Italy.

Askew, S.D. and J.W. Wiltcut. 2001. Tropical cotton interference in cotton. Weed Sci. 49(2):184-189.

Bayan, H.C. and P. Saharia. 1998. Effect of weed management and phosphorus on kharif green gram (*Vigna radiata* L.). J. Agric. Sci. Soc. North East 9(2):151-154.

Beltrao, N.E., M.D.J. de Vieira, L.B. da Nobrega, D.M.P.de Azevedo, and O.R.R.Ferreiraida-Silva.1997. Estimation of the competition period between weeds and sesame plant in the state of Paraiba.

Comunicado-Tecnico-Centro-Nacional-de-Pesquisa-de-Algodao 45:7-12.

Bennet, M. 1993. Sesame Research Report 1991-92. Wet season, Katherine Northern Territory, Australian Department of Primary Industries and Fisheries, Tech. Bull. No. 215.

Bennett, M., Katherine, and B. Condé. 2003. Sesame Recommendations for the Northern Territory. Agnote 657 (C22):1-4.

Bunting, S. and J.W. Ludwig. 1964. Plant competition and weed control in maize. Proc. Seventh British Weed Control Conf., 7:385-388.

Gleason, L.S. 1956. Weed control in the wet tropics. Proc. North Central Weed Control Conf. 13: p. 54.

GOP. 2010. Economic Survey of Pakistan 2009-10. Ministry of Food and Agriculture, Federal Bureau of Statistics, Govt. of Pakistan, Islamabad, p. 21.

Isik, D., H. Mennan, B. Bukun, A. Oz, and M. Ngouajio. 2006. The Critical period for weed control in corn in Turkey. Weed Tech. 20(4):867-872.

Jannink, J.K., J.H. Orf, N.R. Jordan and R.G. Shaw. 2000. Index selection for weed suppressive ability in soybean. Crop Sci. 40(4):1087-1094.

Khan, A.H. and A.H. Sheikh. 1985. Sesame: An important oil seed crop (Urdu). Publication Division, Ayub Agric. Res. Inst., Faisalabad, pp. 1-4.

Knezevic, S.Z., S.P. Evans, E.E. Blankenship, R.C. Van Acker and J.L. Lindquist. 2002. Critical period for weed control: the concept and data analysis. Weed Sci. 50:773–786.

Martinkova, Z.A. and A. Honken. 2001. The effect of time of weed removal on maize yield. Rostlinna Vyroba 47(5):211-217.

Muhammad, N. and S. Ahamd. 1999. Critical period of weed competition with the growth of mungbean. Pak. J. Biol. Sci. 2(4):1608-1610.

Namiki, M. 1995. The chemistry and physiological functions of sesame. Food Rev. Int., Marcel Dekker, Inc. 11:281-329.

Narkhede, T.N., S.C. Wadile, D.R. Attarde and R.T. Suryawanshi. 2000. Integrated weed management in sesame under rainfed condition. Ind. J. Agric. Res. 34(4):247-250.

Nazir, M. S. 1994. Crop Production. National Book Foundation, Islamabad, Pakistan, pp. 358-359.

Nieto, J.N., M.A. Brondo and J.T. Gonzalez. 1968. Critical periods of the crop growth cycle for competition from weeds. PANS 14:190-194.

Pascua, A.C. 1988. Duration of weed control and weed competition of mungbean yield. Philippines J. Crop Sci. 13:230-35.

Ryu, S.R., J.I. Lee, S.S. Kang and C.Y. Choi. 1992. Quantitative analysis of antioxidants *(Sesamum* and *Samolin*) in Sesame seed. Korean J. Crop Sci. 37(4): 377–382.

Serogy, S.T. 1992. Some sesame varieties and their response to planting methods and hand weeding. Assiut J. Agric. Sci. 23(2):151-164.

Shamna, S.N. and P.J. Mishra. 1997. Weed control in Indian mustard. Cruciferae Newsletter, 19:123-124.

Singh, D., J.C. Dagar and B. Gangwar. 1992. Infestation by weeds and their management in oilseed crops-a review. Agri. Rev. 13:163-175.

Sootrakar, B.P., K.N. Namedeo and L.J. Khare. 1995. Effect of weed control on productivity of sesame. Ind. J. Agron. 40(30):454-458.

Spader, V. and R.A. Vidal. 2000. *Brachiaria plantaginea* interference in the agronomic characteristics, yield components and grain of corn. Planta-Daninha. 18(3): 465-470.

Steel, R.D.G., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics. A Biometrical Approach. 3rd ed. McGraw Hill Book Co. Inc. New York. pp. 400-408.

Vats, M.S. 1940. Excavations at Harappa. Calcutta, India.

Venkatakrishnan, A.S. and P. Gnanmurthy. 1998. Influence of varying period of crop-weed competition in sesame. Indian J. Weed Sci. 30:209-210.

Weaver, S.E. and C.S. Tan. 1983. Critical period of weed interference in transplanted tomatoes (*Lycopersicon esculentum*): growth analysis. Weed Sci. 31:476-481.

Weaver, S.E., M.J. Kropf and R.M.W. Groeneveld. 1992. Use of ecophysiological models for crop-weed interference: the critical period of weed interference. Weed Sci. 40:302–307.

Zafar, M., A. Tanveer, Z.A. Cheema and M. Ashraf. 2010. Weed-crop competition effects on growth and yield of sugarcane planted using two methods. Pak. J. Bot. 42(2): 815-823.

Zewdie, K. 1996. Importance of yield limiting factors on sesame under irrigation at Werer, IAR. Newsletter Agric. Res. 11(2):6.

Zimdahl, R.L. 2004. Weed Crop Competition: A Review, 2nd ed. Page 220. Blackwell Publishing.