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IMPACT OF WEED COMPETITION ON GROWTH AND YIELD OF PROSO MILLET (*Panicum miliaceum* L.): IMPLICATIONS FOR FARMERS

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ABSTRACT

Climate resilient proso millet (*Panicum miliaceum L.*) is viable option to mitigate increasing abiotic stresses due to climate change and food security in the long run. An experiment was conducted at research area of MNS-University of Agriculture, Multan in 2019 to evaluate the impact of weed competition on growth and yield of proso millet. Proso millet variety Upea was sown in the last week of February 2019 with 20 cm row to row spacing using 5 kg seed per acre. Experiment was comprised of treatments of weeds competition period for viz; zero competition, competition for 2 weeks after emergence (WAE), competition for 3 WAE, competition for 4 WAE, competition for 5 WAE and competition for full season. Result indicated that maximum number of weeds (plants m^{-2}) were noted when weeds competed with proso millet for full period. Increase in total weed-dry weight was recorded when allowed the weeds to compete with crop for whole season. Highest plant height (16.18), 100-grain weight (74.72 t ha^{-1}), crop dry matter and chlorophyll contents (16.62 t ha^{-1}) were noted where, weeds were kept weed free throughout whole season. Highest economic yield of crop was observed where weeds were competed with crop for five weeks after emergence, and it was statistically similar with control. Maximum yield and yield components were recorded from C2 (competition for 2 weeks after emergence) was provided significant results. Likewise, highest grain yield (1890 kg/ha) were recorded under C2. Farmers should remove weeds from proso millet in two to three weeks after emergence. Extension agents should persuade farmers for the post emergence control in first 2-3 weeks of the crop.

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INTRODUCTION

Proso millet is small seeded annual cultivated cereal crop throughout the world (*Panicum miliaceum* L.) cultivated as a food, feed, fodder and fuel which belongs to family poaceae. It is short duration crop and have ability to escape drought by completing its life cycle within 60-90 days (Baltensperger, 2002). It can grow at higher latitude of about 54°N than other millets and is also well adapted to hilly areas from 1200m to 3500m (Hanna *et al.*, 2016). It is well known for its nutritional

value throughout the world. Its seeds are rich source of protein 12-13% (Ramesh *et al.*, 1998), starch (70-80 %) which is further processed in food industry for development of various food products (Wen *et al.*, 2014). It is drought tolerant crop as compared to other millets (Nielsen and Vigil, 2017). Owing to this, it is getting more and more attention in the present agricultural scenario due to adaptability as a climate resilient crop and its human health benefits (Das *et al.*, 2019).

Weed infestation is serious threat and is bottleneck for the successful production of proso millet. Weeds adversely affect quality of crops and their yields (Javaid *et al.*, 2007). Weed competition deteriorates the quality of produce and loss its market value. Weeds compete with crop for space, which ultimately reduces vegetative growth of crop (Wright *et al.*, 2001). Weeds have a negative impact because they reduce input efficiency, increase cost of production, act as alternative hosts to insects and other pathogens (Ikram, 2018). The main weeds of proso millet included itsit, deela, tandla, lehli, khable ghass, bathu and jangli chulai (Mishra *et al.*, 2018). Proso millet yield is significantly reduced when farms are heavily infested with weeds, and weed control was delayed (Kwiatkowski *et al.*, 2020). Many weeds like Chenopodium album, Amaranthus viridis and Solanum nigrum contain high amount of nitrate which when fed to livestock results is serious problems like troublesome breathing, stunted growth, premature abortion or even death of foetus (Casteel and Evans, 2004). Weed competition depend on density, duration of infestation and the infesting weed species.

Therefore, this study was conducted to enumerate the effects of weeds competition period and weed density on the growth and yield of proso millet and to determine the critical period of weeds control in proso millet.

METHODOLOGY

Present study was carried out at the Agronomic Research Area, MNS-University of Agriculture Multan, during spring 2019. The soil type was sandy clay loam with EC 3.96 dSm^{-1}, pH 8.1 and organic matter 0.74%. Total available nitrogen, phosphorous and potassium were 0.051%, 8.20 mg kg^{-1} and 225 mg kg^{-1}, respectively. The experiment was laid under RCBD with three replications. Crop was sown by maintain R x R distance 20 cm. Experiment was comprised of six treatments i.e., weeds competition period was zero competition, competition for 2 weeks after emergence (WAE), competition for 3 WAE, competition for 4 WAE, competition for 5 WAE and competition for full season. Land preparation was done by using rotavator followed ploughing and planking. Single row hand drill used for sowing. Seed rate of 5 kg per acre was used. Phosphorus, Potash and Nitrogen 30, 50, 40 kg/acre respectively, was applied. Phosphorus and potassium were added in the soil at the time of sowing as complete dose of recommended and half of urea was applied at the time of sowing. Rest of urea was applied at first irrigation as side dressing.

After prescribed crop-weed competition period weeds were eradicated by manual weeding from experimental treatments, throughout the full seasons. First irrigation was applied after 35 days of sowing and the last irrigation was applied 55 days after sowing. All other agronomic practices were kept constants for all the experimental plots during the growth period of a crop. After prescribed weed competition duration, a quadrate measuring 1m × 1m was randomly placed at two sites in the respective plots to record weeds density. Weeds were counted and then cut from ground surface for recording fresh and dry weight. After measuring the fresh weight, weed samples were oven dried at 70oC to a constant weight and dry weight was recorded.

Plants were randomly selected from all experimental units to record observations like plant height, 100-grain weight, crop dry matter, chlorophyll contents and economic yield. Plant height was recorded by choosing 10 randomly chosen plants. After threshing and drying, weight of 100-seeds was measured with help of analytical weight balance. Three plants from each experimental plot were selected randomly for calculating the chlorophyll contents at the interval of ten days and average was calculated. Economic yield of each experimental unit was manually threshed. Winnowing was carried out to separate the seeds from straw and seed yield was computed by digital weighing balance and it is expressed as kg/ha. Total dry matter from each experimental plot was recorded 10 days interval from two different sites of each experimental plot by using one square meter quadrate and then cut from ground surface for recording fresh and dry weight. After measuring the fresh weight, samples were oven dried at 70oC for 48 hours to a constant weight and dry weight was recorded. Recorded observations were analyzed by using technique of Fisher's analysis of variance while treatments means were compared through the use of

Tukey's Honest Significance Difference (HSD) test at 0.05 probability level Steel et al. (1997).

RESULTS AND DISCUSSION

Weeds density (m^{-2})

Results indicated significant influence of different weed competition periods on weeds density in proso millet (Figure 1). Highest weeds population (72.7 plants m^{-2}) was recorded from where, weeds competed for five weeks after emergence of crop. However, the minimum weeds density (33.9 plants m^{-2}) was observed where weeds competed with crop for two weeks after emergence. It is due probably that weeds were competed with crop for least time. Weeds density was attributed to reduced growth period during which weeds took less time to compete with proso millet crop for various agro-environmental resources like, light, soil moisture, space and nutrients acquisition and finally lowest total weed stand and density (Khan *et al.*, 2002). An increase in weed flora up to five weeks was observed after emergence of crop and this situation remain constant till maturity. Results of Maqbool *et al.* (2006) also supported our outcomes they concluded that weeds population in maize crop increases with proliferation in duration of weed interference but for specific time. Discoveries of Malik *et al.* (1998); Dhanapal *et al.* (2015) also reported that maximum weed population and weeds dry weight recorded in weedy check plot on finger millet.

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

The effect of weed competition period on weeds dry weight is depicted in Figure 2. Highest weeds dry biomass (56.9 g m^{-2}) was noted where weeds were allowed to interfere with crop during whole growing season. Lowest value of weeds dry weight (37.5 g m^{-2}) was observed where weeds were allowed to interfere with crop for two weeks. Results of Cheema et al. (2005) also supported our outcomes they reported that total dry weight increase with enhanced in age of weeds. At 45 days after emergence of crops, weeds were attained maximum dry weight because of weeds at their full boom. Broad leaves weeds contain maximum weight as compared to narrow leaves weeds. Broad leaves weeds form a carpet on the soil surface causing more competition than narrow weeds results reduction in yield. Results of Tripathi and Singh (1987) also sustained our outcomes who concluded that significantly dry weight decreases as weed crop-competition period decreases. (Maqbool *et al.*, 2006) reported that more weed-dry weight was produced when maize crop faced competition with the weeds throughout the growing season.

Plant height (cm)

Different weeds competition periods impact on weeds of proso millet crop is shown in Figure 3. Considerably maximum proso millet plant height (75.3 cm) was recorded from the experimental unit where, there were no weeds during whole growth period. While the lowest plant height (52.4 cm) was found from the experimental unit where, allowed the weeds to interfere with proso millet for full crop growth season. Findings of Arif *et al.* (2010) are also in line with our results who reported optimum plant height was obtained where, experimental unit was kept weed free. Plant height increased with crop age and maximum height was recorded during harvest. Crop biomass increased with declined in weed population and weed dry biomass where there no competition between crops and weed. There was decrease in plant height due to weed competition in maize (Soliman and Gharib, 2011).

Chlorophyll contents

Impact of weeds on chlorophyll contents of proso millet due to various weeds competition periods is presented in Figure 4. Maximum chlorophyll contents (44.2) were recorded in the treatment where, weeds were permitted to compete under controlled treatment, where no weeds are present. The chlorophyll content was considerably highest in weed free experimental unit, then all other experimental units. On the other hand, chlorophyll content of proso millet was (33.4) in the experimental unit where, weeds were permitted to interfere for whole season competition of weed. This might be due lower weed population and dry biomass caused lowest interference between crop and weed and so the proso millet crop utilized moisture, nutrients and space hence, produced highest values of chlorophyll contents. Work of Laxminarayan and Mishra (2001) supported our results, their findings showed that increase in number of tillers and leaf area index could be due to increase the photosynthetic efficiency of finger millet which induced to produce more biological yield.

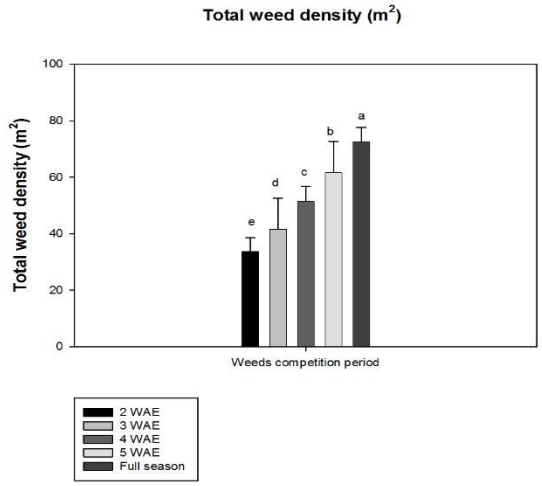

Figure 1. Impact of weed competition period on total weed density (m^2) in Proso Millet.

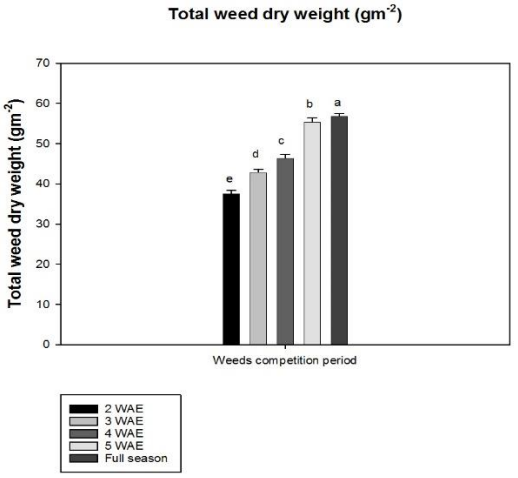

Figure 2. Impact of weed competition period on total weed dry weight (g/m^2)

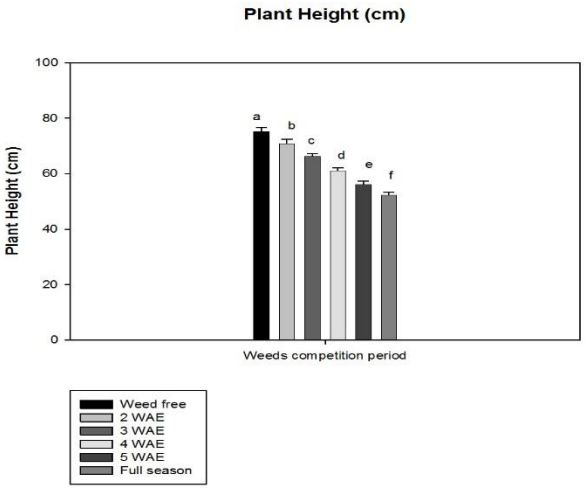

Figure 3: Impact of weed competition period on plant height (cm)

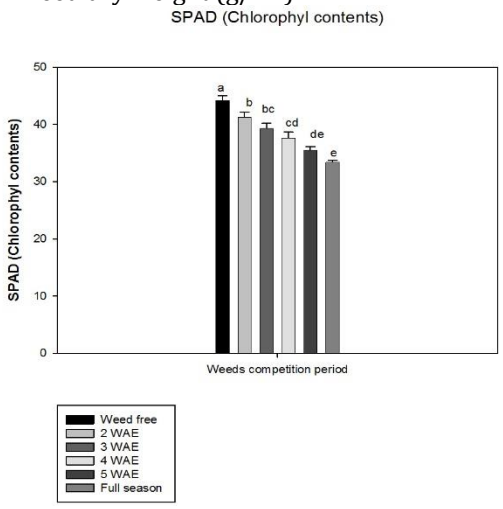

Figure 4: Impact of weed competition period on Chlorophyll contents of Proso Millet

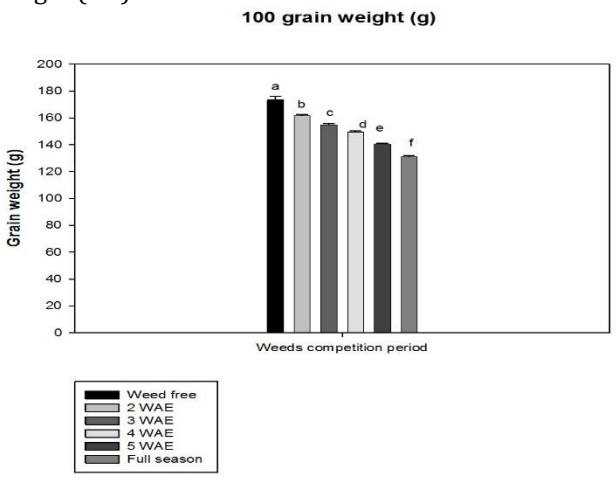

Fig. 5. Impact of weed competition period on 100 grain weight (g) of Proso Millet.

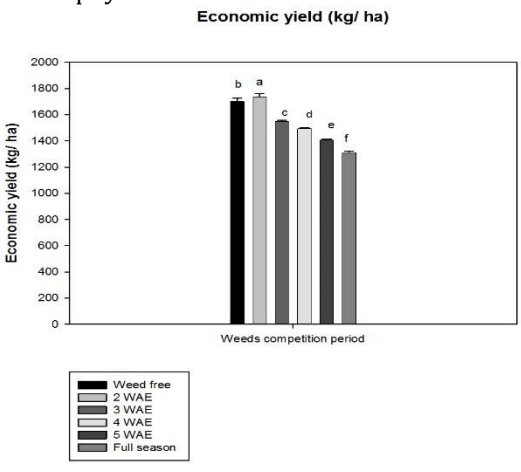

Figure 6. Impact of weed competition period on economic yield (kg/ha) of Proso Millet

100-grain weight (g m^{-2})

Effect of different weed competition periods of weeds on 100- grain weight of proso millet is presented in Figure 5. 100-grain weight was markedly greater (173 g m^{-2}) in weed free treatment than all other experimental units. On the other hand, 100-grians weight of proso millet was lower (131 g m^{-2}) in the experimental plot where, the weeds to grow for whole season competition with proso millet. Reason behind that, under weed free treatment, the crop attained well growth and development. In addition to good aeration weeds were removed from inter and intra row spaces because of manipulation of surface soil, thus providing more spaces for batter growth and development of crops. Hence, light, nutrient and water which has contributed higher yield due to improved growth characteristics. These outcomes are in line with Ebhad (1998) on weed control in finger millet.

Economic yield (kg ha^{-1})

The effect of weed competition period on economic yield of proso millet is presented in Figure 6. The economic yield was significantly higher (1736 kg ha^{-1}) in control, which is similar with the treatment having weed interference for two weeks with the crop after emergence than all other treatments. On the other hand, economic yield of proso millet was lower (1313 kg ha^{-1}) in the experimental plot where, the weeds to grow for whole season competition with proso millet. This may be the lower competition between crops and weeds as compared to other treatments (four, five and full season interference of weeds).

It might be due to the fact that there were optimum conditions for growth and development for crop because of no competition of weeds for nutrients acquisition, light, moisture and space (Hanna *et al.*, 2016; Gramig and Stoltenberg, 2009). Many scientists put forth the results related to our study (Khan, 2004; Gibson, 2000; Gesimba and Langat, 2005; Kwiatkowski *et al.*, 2020). Hence, the proso millet crop fully utilized water, nutrients and light which resulted maximum grain yield because of less weeds population in comparison to other experimental unit.

CONCLUSION AND RECOMMENDATIONS

It is concluded on the basis of findings that critical period for weed-crop competition in proso millet crop lies between first 5 weeks after crop emergence. Whereas highest crop yield and lowest weeds population was noted where weeds were allowed to compete with proso millet for 2 WAE. Hence, weeds should be managed in first two to three weeks after emergence to get maximum economic and biological yield of proso millet. It is recommended for the farmers to manage weeds flora in proso miller within 2-3 weeks in order to get full control over weeds outbreak. It is also recommended that farmers should consult extension agents while choosing the method and weedicides in particular to control weeds. Extension agents should also communicate the same recommendations among farmers.

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