INTERFERENCE OF HORSE PURSLANE *(Trianthema portulacastrum* L.*)*ON GROWTH AND YIELD OF SOYBEAN[*Glycine max* (L.) Merr.]

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ABSTRACT

Horse purslane is one of the most spreading and problematic weed in Pakistan's Punjab region during summer. A field experiment to check the interference of horse purslane (Trianthema portulacastrum L.) on growth and yield of soybean was conducted at research area of MNSUniversity of Agriculture Multan in summer, 2018 The experiment was carried out in Randomized Complete Block Design (RCBD) having three replications and comprising of ten treatments i.e. Weed free (whole season), horse purslane free till 20 Days after emergence (DAE), horse purslane free till 40 DAE, horse purslane free till 60 DAE, all weeds free 20 DAE, all weeds free 40 DAE, all weeds free 60 DAE, Weedy check (except horse purslane), weedy check (only horse purslane), weedy check (all weeds). According to standard procedure data of growth and yield parameters of soybean and weeds were taken.Data was statistically analyzed by using Fisher's analysis of variance (ANOVA) method. Comparison of employed treatment means were done with honest significant difference (HSD), Tukey's test at 0.05 probability. The maximum biological yield was achieved in plots kept weed free over crop growth cycle 6536.0 kg ha^{-1} and statistically minimum yield achieved inweeds free (whole season(5145.4 kg ha^{-1}). While T_7all weeds free till 60 DAE and T_4horse purslane free till 60 DAE treatments attained 6345.8 kg ha^{-1} and 6251.8 kg ha^{-1}, respectively.*T_9 (weedy check only horse purslane) horse purslane sole caused 10.81 percent more yield reduction as compared to T_{10} (weedy check all weeds). Based upon the study, it is suggested that horse purslane should be controlled in soybean fields till 45 DAE to get benefits as the control single weed is economical as compare to all weeds.*

Keywords: Biological yield, competition period,horse purslane, seed yield, soybean.

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INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is animportant oilseed crop that belongs to family Fabaceae with sub-family Papilionoнacea of genus Glycine.It revolutionized the agriculture economy as it is a valuable crop for food, fuel and other products (Reis and Vivian, 2011).Among edible oil crops, soybean edible oil and increasing population over years cause the increase in the demand for edible soybean oil and soybean products also a rich source of dietary protein for chicken and pork industries (Graham and Vanace, 2003).According to UNPF (2017) the 6th Population and Housing Census of Pakistan 2017, Pakistan's population is rising at the rate of 2.4 percent per annum. This fast increase in population is leading to high increasing demand for agricultural products. In 2017-18 the import of soybean oil was increased 13.50 percent of worth 1453.24 million dollars as compared to 2016-17 which was 1244.27 dollars (GOP, 2018).

Weeds are considered as prime limiting element for cost-effective crop production. Weed plants grow faster, spread quickly, reproduce generation in high numbers and produce massive quantities of seeds that make them able to start a kingdom of their own within a short period (Dangwal *et al*., 2010).In soybean crop weed interference is considered as a complex and persistent limitation in many states of the world, by means of its influences on soybean growth and development by causing competition for light, nutrients, water (Vollmann *et al*., 2010). The productivity of soybean crop decreased due to interference by weed that range from 15 to 80 percent in its growing cycle that compete with the crop for resources needed to plants in their growth and development (Scholten *et al*., 2011).

Horse purslane (*Trianthema portulacastrum* L.) is a noxious annual weed considered as a major weed in various agricultural and vegetable crops, such as mustard, corn, pigeon pea, soybean, cotton tomato and potato (Ray and Vijayachandran, 2013), belongs to family Aizoaceae. It is native to South Africa, but extensively present in India, Africa, Sri Lanka, tropical America, West Asia and Pakistan (Saeed *et al*., 2010). It is an annual herb with spreading type habit on the ground in circle and range from 4-6 feet in length,its profuse branching and prostrate growth character rapidly cover the soil and form a structure like green carpet (Senthil *et al*., 2009). Horse purslane is a widely distributed weed that causes adverse effects onthe growth of crop plants (Mubeen *et al*., 2011). Horse purslane has been reported as a major weed in soybean (Idapuganti *et al*., 2005;Tuti and Das, 2011). Horse purslane is considered even more damaging tan the other companion weeds in the same crop field. However, the information on the interference of horse purslane relative to other weeds is scarce. Hence, a need was felt to investigate the effect of horse purslane interference in soybean fields therefore the present study was conducted.

MATERIALS AND METHODS

The experiment was carried out at the research area of Muhammad Nawaz Sharif-University of Agriculture, Multan Punjab Pakistan during the summer (Kharif) season 2018. Sowing of the crop was done during the 1st week of August 2018 by using "Faisal soybean" variety. Physico-chemical analysis of soil showed that soil was loamy in texture, non-saline (2.47mScm^{-1}), slightly alkaline (8.1 pH) with 0.79 % organic matter. Experiment consisted 10 treatments T_1 Weed - free (whole season),T_2 Horse purslane free till 20 Days after emergence (DAE),T_3 Horse purslane free till 40 DAE, T_4 Horse purslane free till 60 DAE, T_5All weeds free till 20 DAE, T_6 All weeds free till 40 DAE, T_7 All weeds free till 60 DAE,T_8Weedy check (except horse purslane), T_9 Weedy check (only horse purslane),T_{10} Weedy check (all weeds for whole season).The production of flowers and seeds of *T. portulacastrum* starts 20-30 days after the germination of seeds. Seed were in pouch

(having 2 to 8 seeds) or between forks of branches. Hard coated seeds are muriculate and dull black. Each plant produces about 52,000 seeds in its life span. Weed density was taken as number of weeds fall in $1m^2$ quadrate area while their dry weight was counted as weeds dry weight.Canal and tube well water was used for irrigation at 20 days interval and total of three irrigations were applied.Height of plants was measured in centimeter, from an area of 1 m^2weight of samples counted as biological yield while harvested seeds from plants taken as grain yield. The climatic conditions of thr experimental site are evodent in Fig. 1. The significant means were compared usingTukey's Honestly Significant Diffence (HSD) test at 0.05 probabilitylevel.

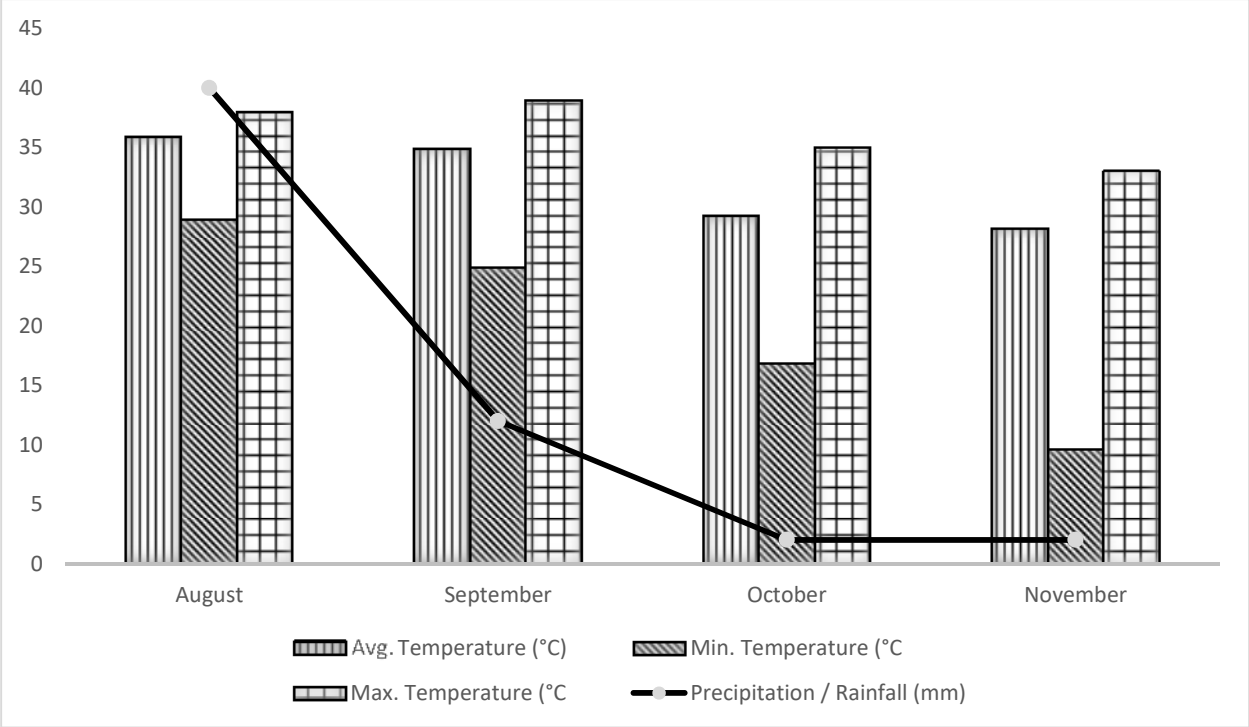

Fig. 1. Agro-metrological data for growing season (Aug-Nov, 2018)

RESULTS AND DISCUSSION

Plant height (cm) of soybean asaffected by weeds interference

Plant height recorded differently for treatments applied in the field. Maximum plant height (67.23 cm) was observed in plots whereweeds free environment was provided to crop for the whole season (Table-1). OneMinimum plant height (39.48 cm) was observed in plots where all weeds grow for whole season.Next minimum plant height was recorded in weedy check only horse purslane) which as followed closely by plant height recorded in weedy check (except horse purslane) and horse purslane free till 20 days after emergence and weedy check only horse purslane.The results are in accordance with those of Hazra *et al*. (2011) who described that plant height reduction happens within the treatment where weedy check all weeds including horse purslane was employed. Maximum plant height was recorded as the result of no competition for resources and nutrients as the result of which resources were utilized by crop whereas uncontrolled growth of weeds for entire season resulted in reduced plant height due to limited availability of nutrients as Ballare and Casal (2000) stated that any change in the intensity and

Biological yield (kg ha^{-1})

The biological yield of soybean responded differently under employed different weedy conditions. In treatment where weeds were kept free for whole season recorded maximum biological yield as weeds were not allowed to compete with crop throughout the season, which was significantly different from all other treatments. Plots where weeds were not allowed to grow till 60 days after soybean emergence resulted 6345.8 kg ha^{-1} and weeds control till 40 days after emergence yielded 6272 kg ha^{-1} while these treatments were followed by those plots where only horse purslane was not allowed to grow till 60 DAE (6251.8 kg ha^{-1}). Minimum biological yield (5145.5 kg ha^{-1}) was observed in plots having naturally growing weeds competition throughout the season as shown in Table-1.As weeds are the major constraint for crop plants to avail resources viz., nutrients, moisture, solar radiation, space and gases, for crop growth.Stress for the nutrients and water impacts the development rate of soybean (Brevedan and Egli, 2003) and weeds are very aggressive with it. Weed crop competition was eliminated in weeds free (whole season) as the result of which ample quantity of resources such as moisture, nutrients, space, and moisture were present for crop utilization which produced maximum biological yield. Increased weed crop competition resulted in lowest biological yield as the maximum amount of resources were consumed by uncontrolled growth and development of weeds incuding horse purslane. Similar finding was communicated by Adelusi *et al*.(2006) who documented the fewer number of pods when weeds competed with the crop for whole season.

Seed yield (g plant^{-1})

A linear decrease in seed yield was observed by increasing the competitive duration of weeds in soybean. The maximum seed yield of 8.91 g plant^{-1} was obtained inplots where no weed was permitted to grow, while the minimum seed yield 5.45 g plant^{-1} was recorded in the treatment where all weeds were growing. Next minimum seed yield was reported in T_8(weedy check except horse purslane) securing 5.50 g plant^{-1} which was followed by the seed yield of T_9 (weedy check only horse purslane) producing 6.04 g plant^{-1}. The decrease in seed yield with increasing weedcrop competition duration was due to a decrease in the number ofplant^{-1}. The reduction in yield due to weed competition was also reported by Akhter *et al*. (2016) and Muhammadi and Amiri (2011) reported thatseed yield of soybean decreased 36 percent when weedy environment over the growing season was compared with weeds free treatment.

Percent yield increase over weedy check all weeds treatment

Percent increase in yield of different treatments was calculated as the treatments have a differential effect on the growth and development of plants. Remarkable increase in yield in plots with weed free whole season situation was observed as shown in Fig. 2 where 53.28 percent more yield was attained as no weed constraint was present that would have limited plant growth. While minimum increase over weedy check all weeds were observed in plots where weedy check except horse purslane treatment was applied. While weeds free whole season treatment was followed by plots where weeds were kept fre until 60 days after crop emergence as there interval for critical crop competition was passed and less damage to crop occurred. In comparison of horse purslane control till 40 days after emergence and all weeds free till 40 days after emergence recorded 30.92 and 46.12 percent yield increase over the weedy check having all weeds, respectively.

Table-1. Effect of horse purslane interference on soybean growth and yield.

Treatments	Plant height (cm)	Biological yield (kg ha^{-1})	Seed yield (g plant^{-1})
All weeds free whole season	67.23 a	6536.0 a	8.91 a
Horse purslane free till 20 DAE	46.270 ef	5843.5 d	6.48 e
Horse purslane free till 40 DAE	50.453 cde	6099.5 c	7.13 d
Horse purslane free till 60 DAE	51.170 cd	6251.8 bc	7.44 c
All weeds free till 20 DAE	48.867 def	6131.8 c	7.88 b
All weeds free till 40 DAE	54.583 bc	6272.0 bc	7.96 b
All weeds free till 60 DAE	58.340 b	6345.8 b	8.05 b
Weedy check except horse purslane	43.683 gh	5338.8 e	5.50 g
Weedy check only horse purslane	45.48 fg	5483.0 e	6.04 f
Weedy check all weeds	39.48 h	5114.5 f	5.45 g
Tukey's HSD value	**4.2172**	**190.17**	**0.2385**

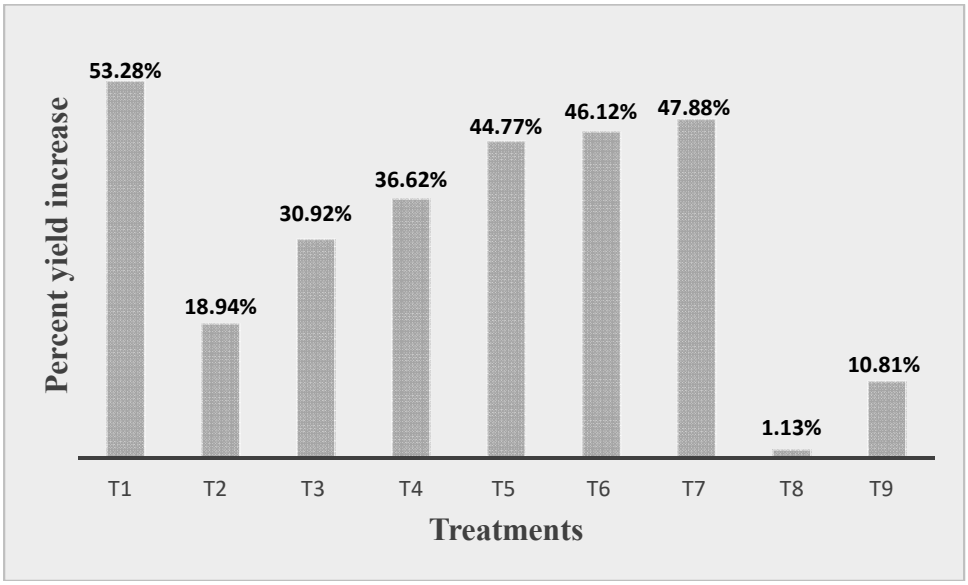

Fig.2. Percent seed yield increase of soybean over weedy check (all weeds) as affected by horse purslane interference.

Weeds density (m^{-2}) at 30, 45, 60 DAE in the soybean field

Weeds density was observed variable for treatments applied in the research fields. At 30 DAE maximum weeds density (32.66 m^{-2})was recorded in plotswhere all weeds grew throughout crop growing season while minimum weeds density (12 m^{-2})in weedy check only horse purslane maintained plotsalthoughplots with all weeds free till 20 DAEand horse purslane free till 20 DAE situationresponded a nearly same value for weeds density as shown in Fig 3.Maximum number of weeds(33.33 m^{-2}) were recorded inplots where horse

purslane was kept free till 20 DAE at 45 days after soybean emergence while minimum density (13 m^{-2}) of weeds was observed in plots where weedy check only horse purslane was maintained,horse purslane free till 40 DAEand all weed free till 20 DAEshows almost similar density of 22.67 and 22.33 m^{-2} andhorse purslane free till 20 DAE plotswas followed by weedy check except horse purslaneand density of 13 m^{-2} horse purslane was observed in weedy check only horse purslane. At 60 days after soybean emergence highest value of weeds density(25 m^{-2}) was present in weedy check of all weeds and minimum density was observed in T_9(weedy check only horse purslane) and at that stage, there was no significant difference among T_3 and T_5 treatments plots.

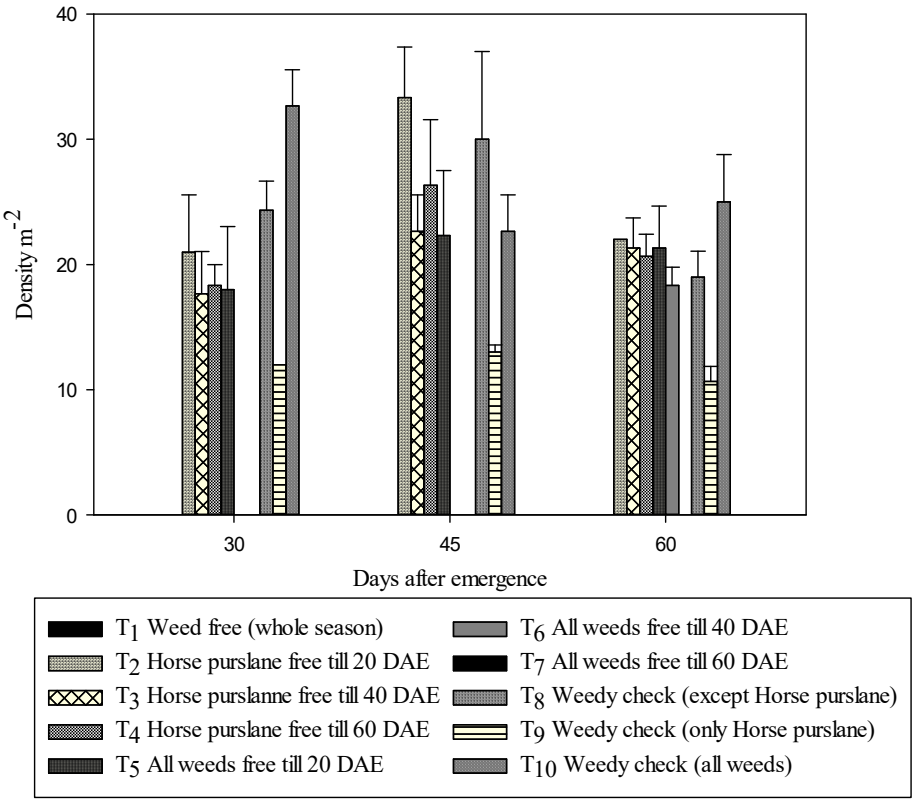

Fig.3.Weeds density 30, 45 and 60 DAE as affected by horse purslane interference in soybean.

Total weeds dry weight (g m^{-2}) at 30,45,60 DAE in a soybean field.

Total weeds dry biomass showed an increasing trend as competition period increased and that increase in weed dry weight with each increased competition period was statistically significant Fig 4. The significantly maximum weed dry weight at 30 DAE was obtained inplots(48.42 g m^{-2}) where weeds were allowed to compete throughout the growing season. Minimum dry biomass of weeds was observed in plots where only horse purslane was controlled till 40 DAE.

At 45 days after emergence significantly maximumdry biomass of weeds (54.44 g m^{-2}) was recorded in plots where all other weeds competed throughout the season while only horse purslane was just control for 20 days and it was statistically at par with treatment of T_8(weedy check except horse purslane) and T_9(weedy check only horse purslane). At 60 days after emergence maximum dry weight was recorded as in T_2 while the dry weight of weeds in other treatments was in decreasing trend as compare to 30 and 45 days after emergence. In weed free

plots zero dry weight of weeds was observed. Maximum dry weight of weeds in horse purslane free till 20 days after emergence may be due to higher weed density and longer growth period and absence of horse purslane in early growth period of weeds resulting in more accumulation of photosynthates and greater biomass as Mubeen *et al*. (2009) reported that horse purslane reduce root growth of adjacent plants due to allelopathic chemicals secretions. The zero dry weight in zero competition treatment was due to complete control of weeds. Muhammadi and Amiri (2011) reported that increasing the weed interference period reduced the soybean yield components.

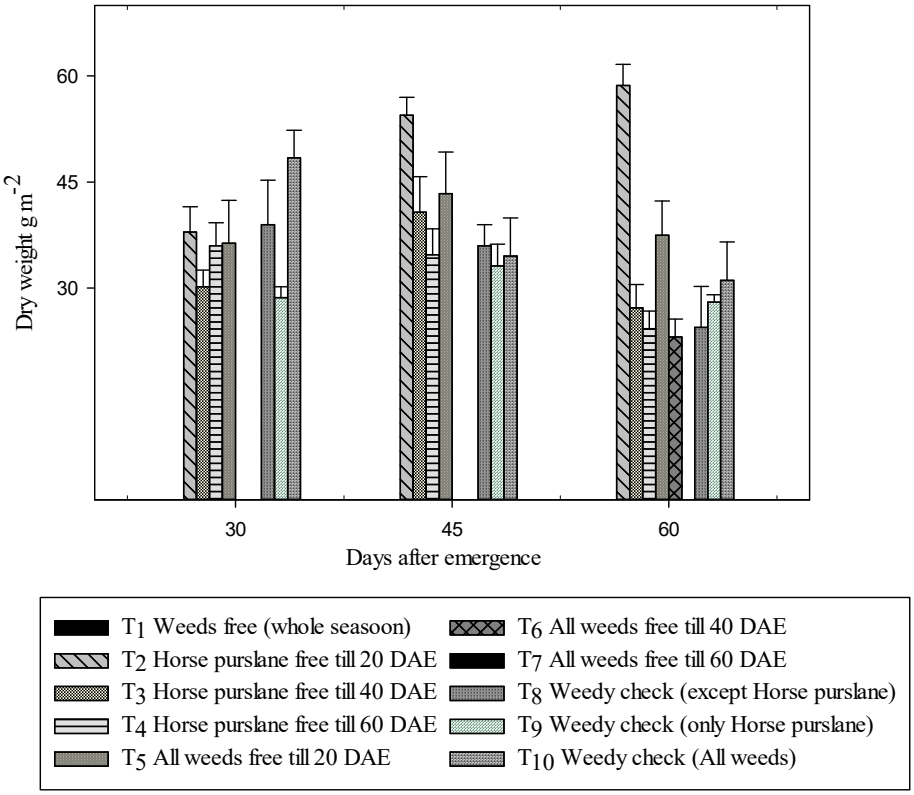

Fig. 4.Total weeds dry weight 30, 45 and 60 DAE as affected by horse purslane interference in soybean.

Horse purslane density (m^{-2}) at 30, 45 and 60 DAE in soybean field.

The perusal of data in Fig. 5 exhibits the at 30 DAE horse purslane, maximum density of horse purslane was observed in treatment where weedy check (only horse purslane) was applied that has 12 horse purslane plant per m^{-2} and minimumdensity of 1.67 plant $m^{-2}$was observed in T_5(all weeds free till 20 DAE), while T_9 (weedy check only horse purslane) was followed by the T_{10} (weedy check all weeds) having 9.33 m^{-2} horse purslane plants. At 45 days after crop emergence density of horse purslane was 13 m^{-2} whereas lowest density was recorded in T_5(all weeds free till 20 DAE) like at 30 days after soybean emergence, although the density of 6m^{-2} of horse purslane was recorded in plots havinghorse purslane free situation till 40 DAE. At 45 DAE its maximum density was observed in plots where weedy check (only horse purslane) was applied that has 13 horse purslane plants per m^2 that were followed by T_{10}(weedy check all weeds)that has a density of 7.33 m^{-2}. At 45 DAE horse purslane density recorded in plots T_2 (horse purslane free till 20 DAE) 6 weed plants m^{-2} while minimum density

was noticed in T_5(all weeds free till 20 DAE) (4.67 horse purslane plants m^{-2}). At 60 days after crop emergence density of weeds tend to decrease as compared to 45 DAE data that was 10.67 m^{-2} in T_9(weedy check only horse purslane) same as in T_{10}(weedy check all weeds) its density reduced to remained 5.33 m^{-2}.That reduction in the weed density may be due to weedscompleting their life cycle. Findings are similar to Singh and Prasad (1994)whoreported that horse purslane is succulent, annual broadleaf and rainy season weed and reached its peak of growth in 45 DAE.

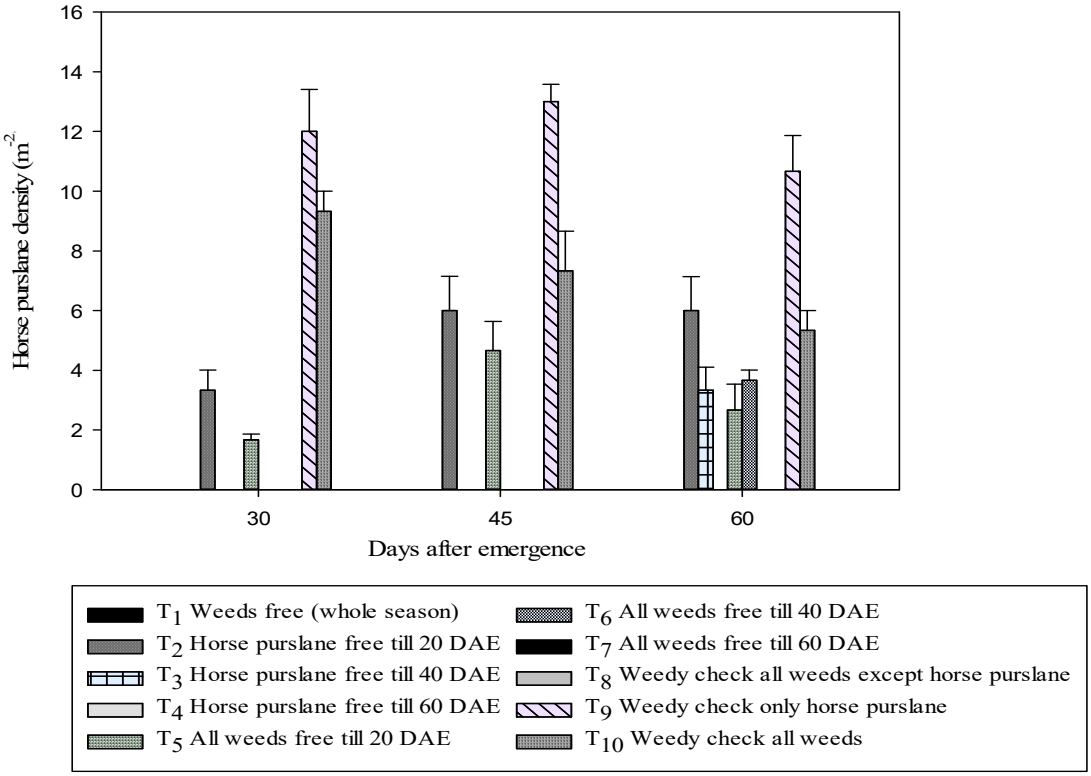

Fig. 5.Horse purslane density 30, 45 and 60 DAE as affected by horse purslane interference in soybean.

Horse purslane dry weight (g m^{-2}) at 30, 45 and 60 DAE in a soybean field.

Horse purslane dry weight 30 DAE was obserdve to be the maximum in weedy check only horse purslane having a dry weight of 28.63g m^{-2} that was statistically at par with the plot where treatment weedy check all weeds that have 24.23 g m^{-2} dry weight whereas minimum dry weight 6.82 g m^{-2} in treatment where all weeds were allowed to grow 20 DAE soybean emergence. At45 days after emergence maximum dry weight of *T. portulacastrum* (33.16 g m^{-2}) was recorded in plots where only horse purslane was kept to compete with the crop. It was statistically at par with all the other treatments as shown in Fig.6 meanwhile minimum weed dry weight recorded in 15.26 g m^{-2} in all weeds free till 20 DAE whereas weedy check only horse purslane treatment was followed by plots wherehorse purslane free condition was imposed till 20 DAE having 25.13 g m^{-2} dry weight.At 60 DAE dry weight was recorded maximum in weedy check only horse purslane having28.02 g m^{-2} and minimum value for the dry weight was observed in plotswhich were kept all weeds free till 40 DAE having a dry weight of 8.53 g m^{-2} and no significant difference was observed in all weeds free till 20 DAEand weedy check all weeds while horse purslane free kept plots till 40 days after emergencefollowed all weeds

free till 20 DAE.The minimum dry weight of *T. portulacastrum* was found in horse purslane free kept plots till 60 DAE and all weeds free till 20 DAE. Horse purslane dry weight was on its peak at 45 days after emergence in weedy check only horse purslaneand lowest dry weight was observed in all weeds free till 20 DAE plots. Dry biomass of horse purslane showeda declining trend after 45 days of crop growth as horse purslane weed is short duration weed and complete its life cycle in someweeks.Critical duration of weed competition range between two to five weeks in soybean and maize, however ,this period has more fluctuations than the critical weed-free duration and is largely determined by site - specific interfaces (Page *et al*., 2012).Crop yield reduction occurs with an increase in the density of weeds that lead to interspecific competition for resources (Baye and Bouhache, 2007).

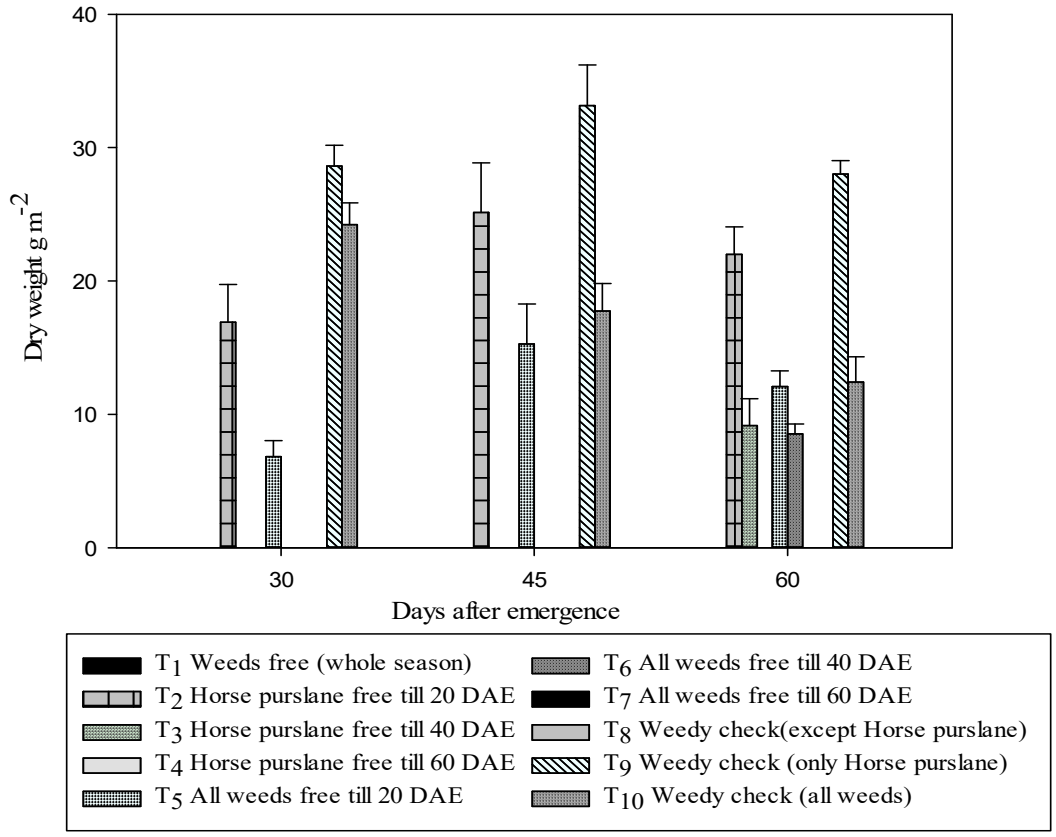

Fig. 6.Horse purslane dry weight 30, 45 and 60 DAEas affected by horse purslane interference in soybean.

At 30 DAE horse purslane density was recorded maximum in 12 m^{-2}in weedy check only purslanewhile lowest of its density was observed in plots with all weeds free situation till 20 DAEhaving 1.67 plants per m^2whereas the maximum density of 32.67 m^{-2}total weeds was observed in weedy check all weeds maintained plots and minimum density for total weeds were recorded in plotswhere only horse purslane was kept to grow. At 45 DAE maximum of horse purslane density 13 plants m^{-2} was observed intreatment where the only horse was allowed to grow throughout crop growth period and although it's lowest density 4.67 m^{-2} was recorded in T_5 (all weeds free till 20 DAE)while highest total weeds

density 33.33 m^{-2} was recorded in where only horse purslane was controlled till 20 DAE and lowest number of weeds 13 m^{-2} was found in weedy check only horse purslane was not allowed to grow till 20 DAE.At 60 DAE horse purslane density was recorded extreme 10.67 m^{-2}in weedy check only horse purslanewhile minimum density was observed in all weeds free till 20 DAEhaving 2.67 plants per m^2whereas the maximum density of 25 m^{-2} total weeds was observed in plots weedy check all weeds and minimum density 10.67 for total weeds was observed in plots where only horse purslane was kept.It was observedthat at 30 DAE horse purslane has a maximum 12 plants^{-2} while at the same duration total weeds have 32.67 m^{-2} density whereas maximum density at 45 DAE for horse purslane and total weeds was 13 m^{-2} and 33.33 m^{-2}, respectively.Although maximum density for horse purslane at 60 DAE was 10.67 m^{-2}whereas total weeds have 25 m^{-2} that showed horse purslane density reached it maximum in soybean at 45 DAE and then tend to decrease at 60 DAE,likewise the density for total weeds increase till 45 days soybean emergence then their density decrease. Our results are supported by Muhammadi and Amiri (2011) who stated that critical weed crop competition goes upto9 to 52 days after emergence.Hand weeding at 25 and 45 DAS show the lowest number of weed index and less weed population(Karande *et al*., 2008).

The dry weight of horse purslane at 30 DAE was maximum (28 g m^{-2}) in weedy check only horse purslane plotswhile total weeds have 48.43 g m^{-2} maximum dry weight in weedy check all weeds, value of maximum 33.16 g m^{-2} horse purslane dry weight at 45 DAE was observed in T_9 (weedy check only horse purslane) whereas total weeds showed 54.44 g m^{-2} dry weight in horse purslane free kept plots till 20 DAE and data at 60 DAE indicate that 28.2 g m^{-2} horse purslane dry weight in weedy check only horse purslane.On the other hand, all other prevailing weeds have 58.68 g m^{-2} maximum dry weight. Data showed that in treatment where only horse purslane left free to compete with crop obtained significant dry weight as the horse purslane has more space and all other factors like nutrient, water moisture and light in abundanceand as a result, it gained more dry weight in that treatment.Hazra *et al*. (2011) described that horse purslane plants alone in crop uptake more N and P as compared to horse purslane in integration with other weeds.While in treatment where all weeds were kept in whole crop growing season revealed highest dry weight due to the fact that these had no restriction for growth that revealeddetrimental dry weight.Although maximum dry weight in horse purslane free till 20 DAEwasdue to the fact that weeds were eliminated till 20 days after soybean emergence so their growth resulted in late maturity and dry weight remained maximum at 45 and 60 DAE as weeds gained maximum dry weight in 3 to 5 - week interval.

At 30 DAE horse purslane density was recorded maximum (12 m^{-2})in weedy check only horse purslaneand maximum dry weight (28 g m^{-2}) was also observed in weedy check only horse purslanewhereas maximum density of 32.67 m^{-2} and 48.43 g m^{-2} dry weight in weedy check all weeds. At 45 DAE maximum density and dry weight of horse purslane plantswere 13$m^{-2}$and 33.16 g m^{-2} respectively in plotswhere only horse purslane was allowed to grow over the crop growth cycle,maximum total weeds density and dry weight was recorded in horse purslane free till 20 DAE 33.33 $m^{-2}$and 54.44 g m^{-2},respectively.At 60 DAE horse purslane density was recorded the most 10.67 m^{-2}in weedy check only horse purslane as that treatment has a maximum dry weight of 28.2 g m^{-2}although total weeds density was observed maximum 25 m^{-2} dry weight was 58.68 m^{-2}in horse purslane free till 20 DAE.Field data show that the density of horse purslane was increasing till 45 DAE and then tend to decrease at 60 DAE.

Likewise, dry weight although total weeds have a different set of expression and damage extent, their density and dry

weight remained maximum in weedy check all weedsplots till 30 DAE but at 45 DAE density and dry weight was maximum in horse purslane free till 20 DAEwhile at 60 DAE highest density was observed in weedy check all weeds maintained plots.(25 m^{-2}) but the dry weight was higher in horse purslane free kept plots till 20 DAE(58.68 g m^{-2}).It could be attributed to the fact that some prevalent weeds like purple nutsedge are perennial in nature showedmore density but couldn't achieve higher biomass as compared to annual broadleaf weeds like horse purslane making it more damaging for interference between crop and weed in less period of time. At 45DAE soybean crop was between flowering to pods formation stage and that period is counted critical for soybean for having weeds.Critical duration of weed competition range between two to five weeks in soybean and maize (Page *et al*., 2012), however, this period has more fluctuations than the critical weed-free duration and is largely determined by site - specific interfaces.Critical weed crop competitionrange from 9 to 52 days after soybean emergence(Muhammadi and Amiri, 2011).

CONCLUSIONS

All weeds removed plots resulted in 53.28 percent more seed yield whereas weedy check onlyhorse purslane resulted in 10.81 percent more seed yield of soybean as compare to weedy check all weeds.Horse purslane density at 30 DAE was 12 m^{-2} with dry biomass of 28.63 g m^{-2} as other weeds has 24.33 plants m^{-2} having a dry weight of 38.96 g m^{-2} while at 45 DAE horse density was recorded 13 m^{-2} with a dry weight of 33.16 g m^{-2} as other weeds have 30 plants m^{-2} gaining dry weight of 35.97 g m^{-2} while density and dry weight horse purslane and weeds started to decrease at 60 DAE. It indicates that horse purslane sole has overall more aggressivity than other prevalent weeds. Weeds control in soybean throughout the growing season resulted in maximum grain yield, it is not economical to control weeds throughout season and control of single horse purslane at 45 in soybean provides good benefits.

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