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EFFECT OF WEED DENSITY ON LEAF AREA INDEX AND BIOLOGICAL YIELD OF MAIZE

MUHAMMAD SAEED[1]*, KHAN BAHADAR MARWAT[1], BAKHTIAR GUL[1] AND ZAHID HUSSAIN[1]

[1]*Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan.*
[2]*Institute of Plant Sciences and Biodiversity, University of Swat, Pakistan*
[*]*E-mail: msaeedws@yahoo.com*

Abstract

Competition studies between maize and weed were undertaken during summer season of 2006 and 2007 at Agricultural Research Farm, Khyber Pukhtunkhwa Agricultural University Peshawar, Pakistan. A Randomized Complete Block (RCB) design was used with split plot arrangements, having twenty eight treatments and three replications. Four plant spacings viz., 15, 20, 25 and 30 cm were allotted to main plots while seven weed densities of 0, 3, 6, 9, 12, 15 and 18 plants m^{-2} were assigned to the sub plots. Data were recorded on days to tasseling, days to maturity, leaf area index and biological yield (t ha^{-1}). Narrow plant spacing of 15 cm resulted in higher leaf area index and biological yield in comparison with 30 cm plant spacing. Biological yield and leaf area index decreased with increasing weed density. Similarly days to tasseling and maturity were also delayed by increasing weed density.

Introduction

Maize is the third main cereal crop after wheat and rice in Pakistan and second after wheat in Khyber Pukhtunkhwa. Owing to its significance in industries and food, maize requirements are increasing rapidly (Arif *et al*., 2011). The area under maize cultivation in Pakistan and Khyber Pukhtunkhwa was 1052.1 and 509.5 thousand hectares, with production of 3593 thousand tonnes and 957.9 thousand tones and average yield of 3415 and 1880 kg ha^{-1} in Pakistan and Khyber Pukhtunkhwa, respectively (Anonymous, 2009). An increase of one kilogram of weed growth corresponds to a reduction of one kilogram of crop growth (Rao, 2000). Increasing weed density reduced plant height and biological yield of maize (Oljaca *et al*., 2007; Arif *et al*., 2010). In a study maize kernel weight, ear weight and leaf area declined with decreasing plant spacing (Saeed *et al*., 2010; Sajid, 2003). Horse purslane (*Trianthema portulacastrum* L.) a member of family Aizoaceae, is a major weed of maize, soybean and cotton (Hashim & Marwat, 2002). Gupta & Mukerji (2001) also reported *T. portulacastrum* as a noxious weed posing considerable competition with maize crop. Optimum plant spacing, particularly in fields infested with weeds is a key factor to reduce weed infestation and achieve high yield through shading the soil. Leaf area index increased under high plant population of maize (Berzsenyi & Dang, 2007). Total biological yield was greater under narrow plant spacing but individual plant yield was higher under wider plant spacing (Randhawa, 1995). Wider spacing amongst plants improved the growth and yield of single plant but did not compensate the total yield obtained from narrow plant spacing (Thakur *et al.,* 1997; Gul *et al*., 2011). Therefore, suitable plant spacing is one of the key factors for enhancing maize competiveness, weed suppression ability and achieving high biological yield. Due to aggressiveness of *T. portulacastrum* in maize crop, experiments were designed for determining the suitable plant spacing of maize crop for suppression of *T. portulacastrum,* secondly to measure the effect of different densities of *T. portulacastrum* on leaf area index and biological yield of maize crop.

Materials and Methods

Two years research was carried out to evaluate the competition of *Trianthema portulacastrum* with maize at Agricultural Research Farm, Khyber Pukhtunkhwa Agricultural University Peshawar, Pakistan during 2006 and 2007, using "Azam" variety. The experimental site is located at 71° 27/ and 72° 47/ east longitude and 33° 40/ and 34° 31/ north latitude and at an altitude of 335 m above sea level. The experiments were laid out in Randomized Complete Block design with split plot arrangements, having three replications. Four maize plant spacings viz., 15, 20, 25 and 30 cm were kept in main plots, while seven weed densities viz., 3, 6, 9, 12, 15 and 18 m^{-2} were allotted to sub plots. Data were recorded on days to tasseling, days to maturity, leaf area index and biological yield (t ha^{-1}). The analyses were performed using MSTATC software and significant means were separated using Least Significant Difference test (Steel & Torrie, 1980). Since treatments were quantitative, spaced at equal intervals, therefore, regression analyses were carried out to determine the trends for the relevant parameter(s).

Results and Discussion

Days to 50% tasseling: Effect of plant spacing, weed (*Trianthema portulacastrum* L.) density and their interaction regarding days to tasseling of maize was significant during both years. Narrow plant spacing of 15 cm took more days to tasseling (55 and 54) compared to wider spacing of 30 cm (52 days) during 2006 and 2007, respectively (Table 1). Delayed tasseling at narrow plant spacing may be due to lower soil temperature and higher humidity under the thick canopies compared to thin canopies in wider plant spacing (Hamayun, 2003 & Naeem, 2004). During 2006, control plots took less days (51) to tasseling, though statistically at par with weed density of 3 plants m^{-2} compared to weed densities of 15 and 18 plants m^{-2} which took more days to tasseling (56 and 57). Similarly in 2007, early tasseling (51 days) was noticed in control plots, statistically at par with weed

densities of 3, 6 and 9 plants m^{-2}. Whereas, weed density of 18 plants m^{-2} took more days (57) to reach tasseling stage (Table 1). Delayed tasseling at higher weed densities may be due to high interspecific competition (Evans *et al*., 2003). Regression analysis indicated that the effect of increasing density of *T. portulacastrum* was curvilinear in both years, except 15 cm plant spacing which showed linear response in 2006. Overall results showed that tasseling was enhanced in wider plant spacing, may be due to less competition (Fig. 1a & b).

Table 1. Effect of maize plant spacing and *Trianthema portulacastrum* densities on some agronomic traits of maize in 2006 and 2007.

	Days to 50% tasseling		Days to maturity		Leaf area index		Biological yield (t ha^{-1})	
Plant spacing (cm)	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
15	55.0 a	54.1 a	93.9 a	92.8 a	2.99 a	2.93 a	6.96 a	6.69 a
20	53.9 ab	53.3 ab	93.1 ab	92.8 a	2.80 b	2.51 b	6.59 b	6.51 a
25	53.0 bc	52.3 b	92.5 b	92.4 ab	2.57 c	1.93 c	6.26 c	6.16 b
30	52.1 c	52.0 b	92.2 b	91.8 b	1.41 d	1.35 d	5.92 d	5.85 c
$LSD_{(0.05)}$	1.71	1.36	1.12	0.72	0.15	0.17	0.28	0.30
T. portulacastrum Density (m^{-2})								
0	51.1 e	50.8 d	91.5 e	90.8 f	2.99 a	2.74 a	7.28a	7.09 a
3	51.6 de	51.2 d	91.7 e	91.3 ef	2.80 b	2.62 b	6.95b	6.73 b
6	52.3 cd	51.7 d	92.1 de	91.8 de	2.60 c	2.45 c	6.67b	6.40 c
9	53.2 bc	52.1 cd	92.7 cd	92.3 cd	2.23 d	2.04 d	6.27c	6.29 cd
12	54.1 b	53.3 c	93.3 c	92.8 bc	1.95 e	1.84 e	6.22c	6.02 de
15	55.7 a	54.9 b	94.3 b	93.5 b	1.85 ef	1.83 e	5.83d	5.94 e
18	56.5 a	56.5 a	95.0 a	94.4 a	1.79 f	1.73 f	5.81d	5.65 f
$LSD_{(0.05)}$	1.06	1.37	0.69	0.76	0.12	0.07	0.33	0.28
Interaction (S x D)	*	*	*	*	*	*	NS	NS

Means of the same category followed by different letters are significantly different at p≤0.05 level using LSD test
NS = Non Significant, * = Significant at p≤0.05

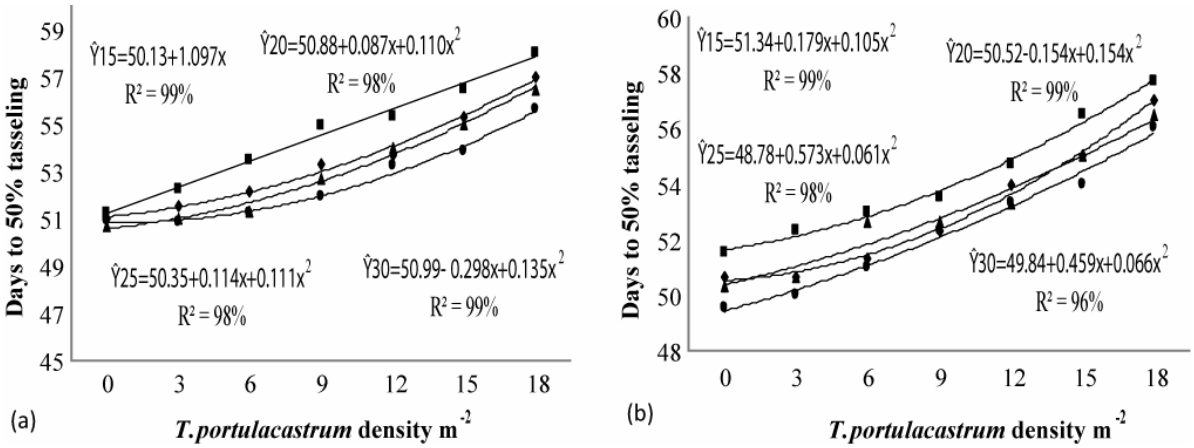

Fig. 1. Interactive effect of plant spacing and *T. portulacastrum* density on days to 50% tasseling during 2006 (a) and 2007 (b) (■ = 15, ♦ = 20, ▲= 25, ● = 30 cm).

Days to maturity: Effect of plant spacing, *T. portulacastrum* density and their interaction during both years on days to physiological maturity of maize was significant. More days (94 and 93) were recorded in 15 cm plant spacing, at par with 20 cm plant spacing compared to (92 days) in 30 cm plant spacing that was statistically similar to 25 cm plant spacing during 2006 and 2007, respectively (Table 1). Decreasing plant spacing prolonged the maturity of maize crop (Waqar, 2002). Among the weed density, check plots took less days to physiological maturity (92 in 2006 and 91 in 2007); however, it was at par with plots having 3 plants of *T. portulacastrum* m^{-2}, whereas 6 and 9 weed densities were also at par with each other in both years. Similarly, higher weed density of 18 m^{-2} resulted in 95 and 94 days to reach physiological maturity in 2006 and 2007, respectively (Table 1). Thus increasing weed density delayed maturity of maize which may be due to competition for resources (Evans *et al*., 2003). Regression analysis revealed that the number of days to maturity increased with increasing weed density in all plant spacings (Fig. 2a & b).

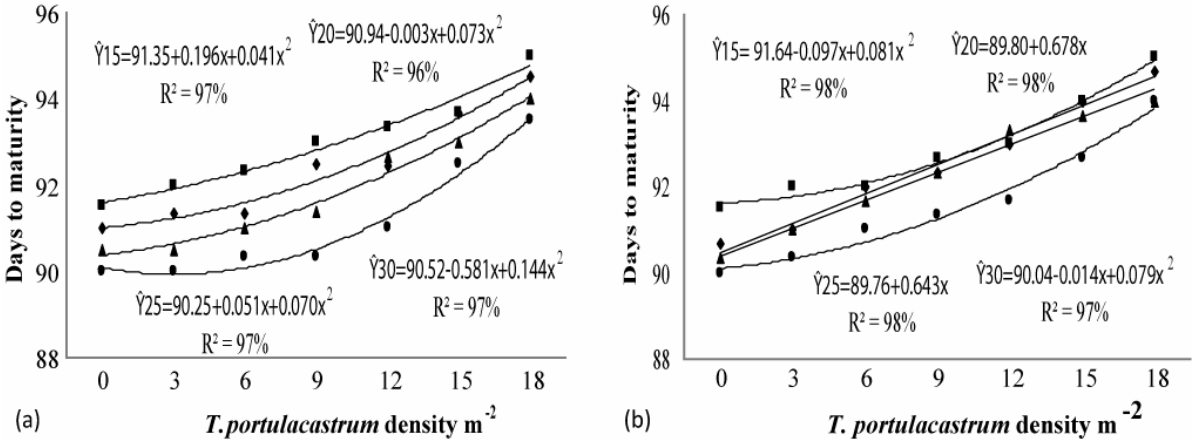

Fig. 2. Interactive effect of plant spacing and *T. portulacastrum* density on days to maturity during 2006 (a) and 2007 (b) (■ = 15, ♦ = 20, ▲= 25, ● = 30 cm).

Leaf area index: Leaf area index was significantly affected by plant spacing and *T. portulacastrum* density and their interaction for both years was also significant. Maximum leaf area index (2.99 in 2006 and 2.93 in 2007) was recorded in 15 cm plant spacing and minimum leaf area index (1.41and 1.35 in 2006 and 2007, respectively) was recorded in 30 cm plant spacing (Table 1). Though the average leaf area plant^{-1} of maize increased with decrease in plant spacing yet the leaf area index decreased with decrease in plant spacing. The higher maize leaf area index at narrow spacing of 15 cm was attributed to greater number of maize plants per unit area (Sajid, 2003; Johnson & Wilman, 1997). Among the *T. portulacastrum* density, higher maize leaf area index (2.99 and 2.74 in 2006 and 2007, respectively) was recorded in weed free plots, while the lower maize leaf area index (1.79 in 2006 and 1.73 in 2007) was recorded in plots having the higher weed density of 18 m^{-2} (Table 1). The leaf area index of maize decreased with each increment in weed density due to increase in weed competition (Tollenaar *et al*., 1994; Williams & Masiunas, 2006). The trend lines showed that leaf area index of maize decreased linearly by *T. portulacastrum* in all plant spacings (Fig. 3a & b).

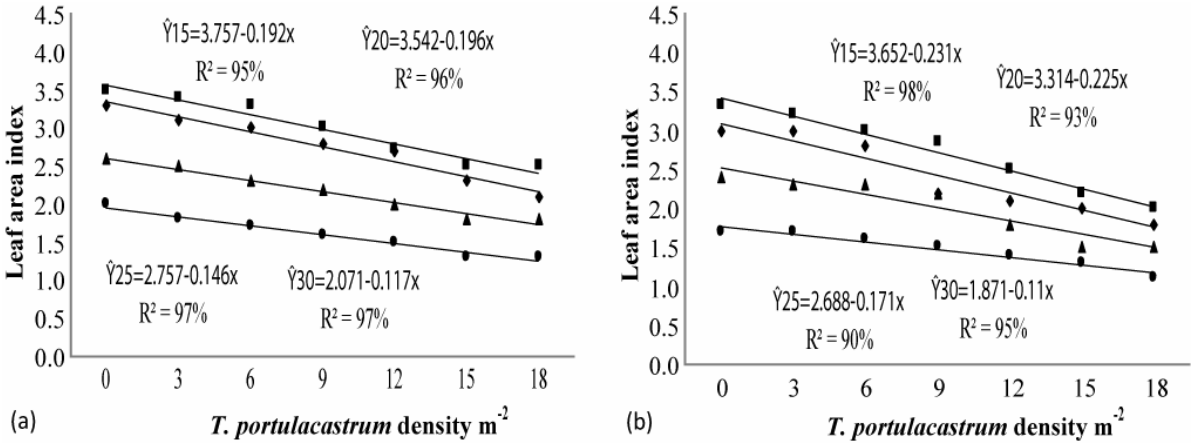

Fig. 3. Interactive effect of plant spacing and *T. portulacastrum* density on Leaf area index during 2006 (a) and 2007 (b) (■ = 15, ♦ = 20, ▲= 25, ● = 30 cm).

Biological yield (t ha^{-1}): The biological yield of maize was significantly affected by plant spacing and weed density; however, the interaction was not significant during both the years. Higher biological yield (6.96 t ha^{-1} in 2006 and 6.69 t ha^{-1} in 2007) was recorded in narrow spacing of 15 cm compared to lower biological yield (5.92 t ha^{-1} in 2006 and 5.85 t ha^{-1} in 2007) in wider spacing of 30 cm (Table 1). In a similar study maize biological yield increased with increasing plant density (Bruns & Abbas, 2003; Naeem, 2004). In case of *T. portulacastrum* density, the higher biological yield (7.28 and 7.09 t ha^{-1} in 2006 and 2007, respectively) was recorded in check plots and lower biological yield (5.81 and 5.65 t ha^{-1} in 2006 and 2007, respectively) was recorded in plots having higher density of 18 *T. portulacastrum* m^{-2} (Table 1). With increasing density of weed the biological yield of maize decreased accordingly (Moti *et al*., 1994; Oljaca *et al*., 2007). The regression analysis showed that during 2006, the biological yield of maize decreased quadratically at all plant spacings, except 15 cm plant spacing which showed linear trend. While during 2007, the narrow (15 cm) and wider plant spacings (30 cm) showed quadratic trend and 20 and 25 cm plant spacings showed linear decreased in biological yield with increase in weed density (Fig. 4a & b).

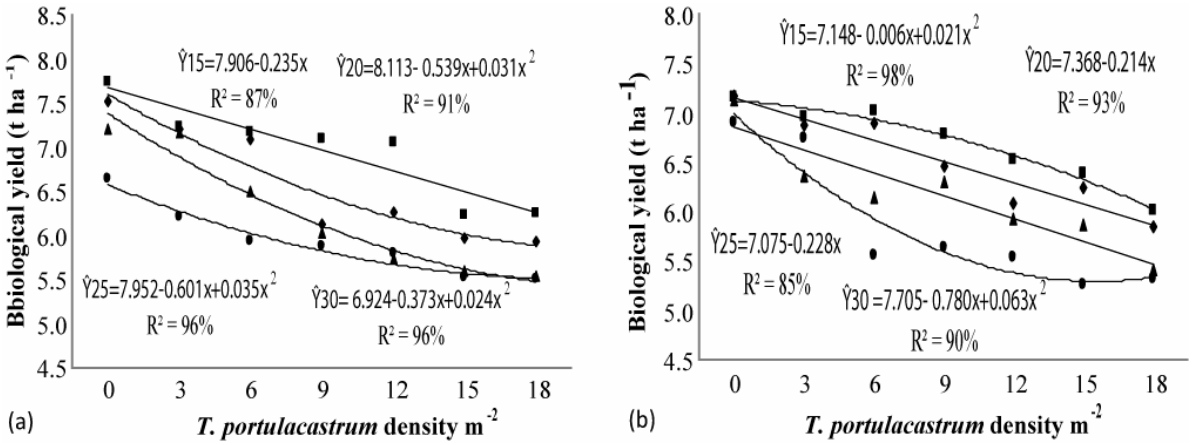

Fig. 4. Interactive effect of plant spacing and *T. portulacastrum* density on biological yield (t ha^{-1}) during 2006 (a) and 2007 (b) (■ = 15, ♦ = 20, ▲= 25, ● = 30 cm).

Conclusion and Recommendations

Narrow plant spacing of 15 cm enhanced the competitiveness of maize crop and reduced the growth of Horse purslane (*T. portulacastrum*). Any density of *T. portulacastrum* was harmful and decreased the leaf area index and biological yield upto considerable level. Higher leaf area index (2.99 and 2.93) and biological yield (6.96 and 6.69 t ha^{-1}) was obtained from 15 cm plant spacing followed by 20 cm plant spacing (2.80 and 2.51) and (6.59 and 6.51 t ha^{-1}) in 2006 and 2007, respectively. Though the losses were reduced in narrow spacing yet it required other control measures along with the narrow plant spacing to keep *T. portulacastrum* below the threshold level.

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