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Competition of *Trianthema portulacastrum* L. with and without Other Weeds in Soybean

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ABSTRACT

In a field experiment, all weeds including *Trianthema portulacastrum* L. (*T. portulacastrum*) and 200 plants/m^2 of *T. portulacastrum* resulted in significantly higher weed/*T. portulacastrum* dry weight, growth rate and relative growth rate than those in other treatments except all weeds excluding *T. portulacastrum*. These treatments caused significant reduction in soybean dry weight, crop growth rate, relative growth rate, leaf area index, net assimilation rate and uptake of N, P and K by soybean. All weeds excluding *T. portulacastrum* were comparable with them on the reduction of most of these parameters. Competition by all weeds including *T. portulacastrum* resulted in significantly lower values of pods/plant, seeds/pod, seeds/plant and seed weight/plant of soybean than other treatments except 200 *T. portulacastrum*/m^2. All the densities i. e. 25, 50, 75, 100 and 200 *T. portulacastrum*/m^2 and all weeds including and excluding *T. portulacastrum* resulted in significantly lower seed yield than weed-free check, but the reductions were greater in all weeds including *T. portulacastrum* and 200 *T. portulacastrum*/m^2. There was significant negative correlation (at $P \leq 0.01$) between the *T. portulacastrum* density and soybean seed yield.

Key words : Competition, growth rate, nutrients uptake, soybean, *Trianthema portulacastrum*

INTRODUCTION

Soybean [Glycine max (L.) Merrill] is an important crop grown in USA, China, India and Thailand. It is first both in acreage and production among oilseed crops grown in India. Soybean, because of initial slow growth, encounters heavy infestation of weeds comprising grassy, broad-leaved and sedges. These weeds cause yield loss in soybean, which ranges from 35 to 55% (Sharma et al., 1995; Ponnuswamy et al., 1996). *Trianthema portulacastrum* L. (Horse purslane; Aizoaceae) is the most important weed, which poses a great threat to soybean production in most areas of the north-western, northern and central plains in India (Arya, 1995). Soybean is heavily smothered by this weed right from the seedling stage (Das and Yaduraju, 1996). The rate at which *T. portulacastrum* grows in branches and leaf area, frequently enables it to suppress growth of soybean and many other crops, and eventually to crowd them out (Singh and Kolar, 1994). Therefore, it is important determining the competition effect of *T. portulacastrum* with soybean.

Soybean density as determined by the seeding rates remains more or less constant, while weed density depending on species distribution varies. The competitive relationship between crop and weed is density-dependent (Cussans et al., 1986; Cousens, 1987). Therefore, the competition effect of different densities of *T. portulacastrum* on growth and yield of soybean is useful for the prediction of yield/yield loss and making decisions for efficient and economical weed management. This experiment, therefore, was undertaken in the field to determine the competitions of T. portulacastrum across densities with and without other weeds in soybean.

MATERIALS AND METHODS

An experiment was undertaken at the Indian Agricultural Research Institute, New Delhi during the wet/rainy season in 2000 under irrigated conditions. Soil was sandy-loam with pH 8.1. The organic C (0.56%), available P (18.9 kg/ha) and available K (202.5 kg/ha) were medium, whereas available and total N (266.4 and 1164.8 kg/ha, respectively) were low in the soil.

Treatments consisting of five densities of *T. portulacastrum* viz., 25, 50, 75, 100 and 200 plants/m^2, weedy check with all weeds including *T. portulacastrum* (WC), all weeds excluding *T. portulacastrum* (WC-TP) and weed-free check (WFC) were laid out in a randomized complete block design with three replications. Huge natural infestation of *T. portulacastrum* plants (>500 plants/m^2) was of usual occurrence in the experimental field. In the *T. portulacastrum* density treatments, all weeds except *T. portulacastrum* were pulled out first and then required *T. portulacastrum* densities were maintained by thinning right from 15 days after sowing (DAS). Soybean was raised as per the practices recommended for its cultivation (Singh, 1996).

All weed species from the WC and WC-TP treatments, whereas *T. portulacastrum* from the *T. portulacastrum* density treatments were sampled by placing quadrat (0.5 x 0.5 m) randomly in each plot. The plant samples were first sun-dried for two days, and then kept in an electric oven at 70^0C for 48 h for estimating dry weight. Soybean leaf area was estimated by a Leaf Area Meter (Model LICOR 3100). Five *T. portulacastrum* plants were randomly chosen for determining their branches/plant, seeds/plant and test weight of seeds. Crop/weed growth rate (CGR/WGR), relative growth rate (RGR), net assimilation rate (NAR) and leaf area index (LAI) of soybean or weed/*T. portulacastrum* were calculated as per Das (2008). In soybean plants, N concentration was determined by Kjeldahl method, P by vanado-molybdo phosphoric acid yellow colour method in HNO_3 medium (using spectrophotometer at 470 nm wavelength) and K by EEL Flame Photometer using tri-acid digestion extract (Jackson, 1973). The uptake of these nutrients was determined from the respective per cent concentration multiplied by dry weight.

RESULTS AND DISCUSSION

Trianthema portulacastrum/Weed Competition

Excluding *T. portulacastrum* L., six other weeds viz., *Acrachne racemosa* (Heyne ex Roem. and Schult) Ohwi (goosegrass), *Digitaria sanguinalis* (L.) Scop. (large crabgrass), *Cyperus rotundus* L. (purple nutsedge), *Digera arvensis* (L.) Forsk. (kigera), *Convolvulus arvensis* L. (field bind weed) and *Commelina benghalensis* L. (tropical spiderwort) were present under weedy check (WC) and WC-TP treatments in soybean. The total population and dry weight of these weeds including *T. portulacastrum* were 784 plants/m^2 and 180.3 g/m^2, respectively. T. portulacastrum was most dominant with 67 and 60% of the total weed population and dry weight, respectively, of the composite stand. Similar dominance of *T. portulacastrum* has been reported earlier (Arya, 1995; Das and Yaduraju, 1996).

The dominance of *T. portulacastrum* led to significantly higher dry weight (Table 1), growth rate (WGR) (Fig. 1a) and relative growth rate (RGR) (Fig. 1b) of weeds under WC than those in other treatments, except 200 *T. portulacastrum*/m^2, which was comparable with WC on all these parameters. The WC-TP and 100 *T. portulacastrum*/m^2 recorded intermediate values of these parameters. The branches and test weight (1000-seed weight) of individual *T. portulacastrum* plant decreased gradually with the increase in its density. The seeds of *T. portulacastrum* being very minute their test weight was not significantly affected by weed competition (Table 1). However, WC and 200 *T. portulacastrum*/m^2 caused greater reduction in these characters than others. In the WC, both intra-specific competitions between *T. portulacastrum* plants and inter-

Table 1. Dry weight, branches and test weight of *Trianthema portulacastrum* and dry weight and plant height of soybean across the treatments

Treatments	*T. portulacastrum*			Soybean	
	Dry weight at 30 DAS (g/m^2)	Branches/ plant	Test (1000-seed) weight (g)	Dry weight (g/m^2) at 30 DAS	Plant height (cm) at 60 DAS
All weeds including TP /weedy check (WC)	140.1*	6.3	1.387	59.5	50.6
All weeds excluding TP (WC-TP)	98.1*	0.0	0.000	61.6	50.3
25 TP/m^2	26.5	12.9	1.403	81.6	56.1
50 TP/m^2	28.9	12.7	1.397	70.9	55.5
75 TP/m^2	37.1	11.3	1.390	65.6	55.3
100 TP/m^2	72.6	10.5	1.390	66.1	54.9
200 TP/m^2	118.0	10.3	1.387	59.7	54.3
Weed-free check (WFC)	0.0	0.0	0.000	99.1	57.3
S. Em±	8.31	0.72	0.0039	4.36	1.03
LSD (P=0.05)	25.21	2.19	NS	13.23	3.12
CV (%)	22.1	15.6	10.6	10.7	9.7

*Dry weights of composite weeds, NS–Not Significant.

specific competitions between *T. portulacastrum* plants and other weeds were responsible for significantly greater reductions of all these parameters. In contrast, only intra-specific competition played role in 200 *T. portulacastrum*/m^2 towards reduction of these parameters. When weed density increases, there occurs concomitant increase in total weed dry weight, but usually at the cost of individual weed dry weight, particularly at higher densities (Zimdahl, 1980; Das, 2001, 2008). This could be the reason why a moderate density of 200 *T. portulacastrum*/m^2 was comparable with a very high density (≅784 plants/m^2) of composite weeds under WC in terms of WGR (Fig. 1a), RGR (Fig. 1b) and dry weight (Table 1) of weeds/*T. portulacastrum*. In the 200 *T. portulacastrum*/m^2, intra-specific competition might have been of lower magnitude due to much lower *T. portulacastrum* density compared to that in WC. As a result, the growth of individual plants was not much affected, and *T. portulacastrum* plants could accumulate comparable total dry weight as that in WC. This corroborated the fact that a moderate infestation of weeds was sometimes as serious as heavy infestation (Akobundu, 1987; Das, 2008). Similar influence of density was observed across the *T. portulacastrum* densities too. *T. portulacastrum* recorded a gradual increase in dry weight (Table 1), WGR (Fig. 1a) and RGR (Fig. 1b) at the increasing *T. portulacastrum* densities, but its branches/plant or test weight decreased

Table 2. Correlation coefficient between *T. portulacastrum* density and different characters of *T. portulacastrum* and soybean

T. portulacastrum characters	*T. portulacastrum* density	Soybean characters	*T. portulacastrum* density
Dry weight at 30 DAS	0.975**	Dry weight at 30 DAS	-0.819**
Branches/plant	-0.534*	Leaf area at 30 DAS	-0.866**
Leaf area/plant	-0.896**	Pods/plant	-0.808**
Fruits/plant	-0.992**	Seeds/pod	-0.626*
Seeds/plant	-0.992**	Seeds/plant	-0.829**
Test weight	-0.738*	Test weight	-0.805**
		N uptake	-0.832**
		P uptake	-0.833**
		K uptake	-0.864**
		Seed yield	-0.822**

*Significant at 5% level (n=18), **Significant at 1% level (n = 18).

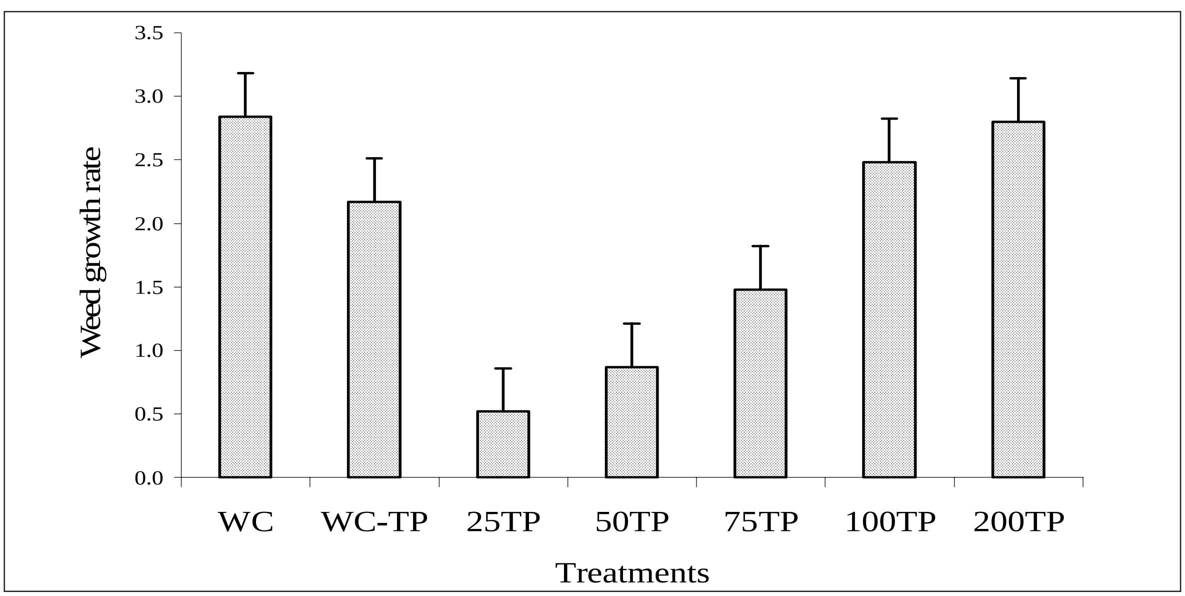

Fig. 1a. Weed growth rate (g/m^2/day) at 30-60 DAS. WC–Weedy check, TP–*T. portulacastrum.*

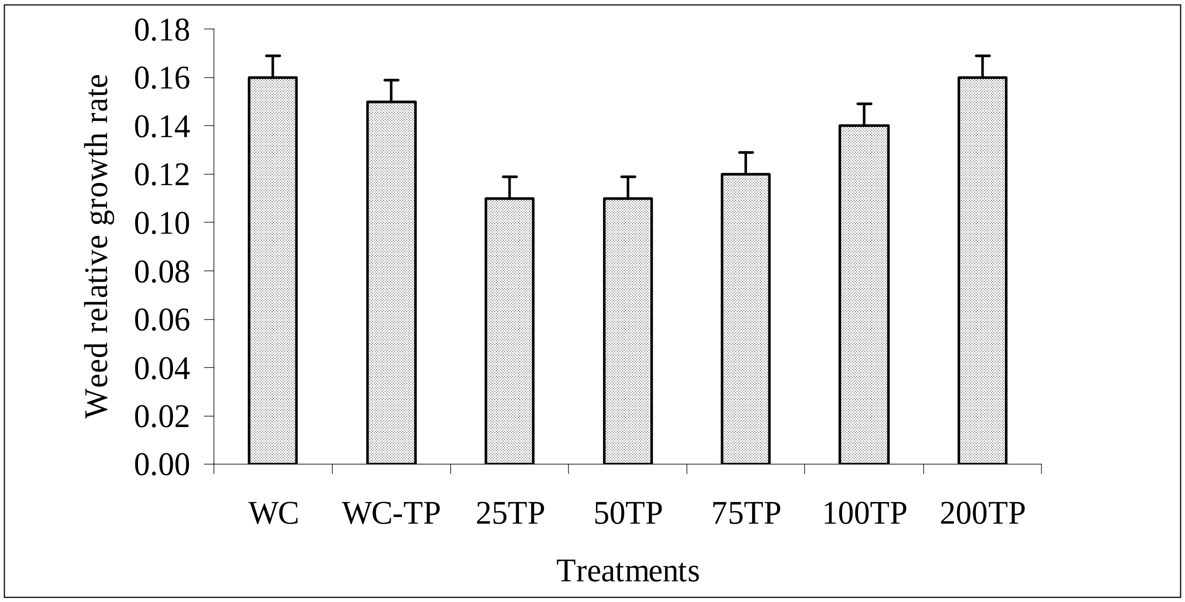

Fig. 1b. Weed relative growth rate (g/g/day) at 30-60 DAS. WC–Weedy check, TP–*T. portulacastrum.*

gradually with increase in density. Significant positive correlation (at P=0.01) between the dry weight and density of *T. portulacastrum*, whereas significant negative correlations (at P=0.01 or 0.05) between the characters like branches, leaf area, fruits, seeds and test weight per *T. portulacastrum* plant and its density (Table 2) also corroborated the fact.

Soybean Growth, Yield Attributes and Yield

Soybean dry weight and plant height were significantly affected due to varying competition offered by weeds/*T. portulacastrum* across the treatments (Table 1). Weed competition with crop in a composite weed culture varies depending upon weed spectrum, crops, seasons/years and environments (Zimdahl, 1980). However, when a single weed species dominates or is present in a crop, the competition is much influenced by its growth in terms of population and dry matter accumulation. A significant negative impact of *T. portulacastrum* density on these characters was observed right at 25 *T. portulacastrum*/m^2 compared to weed-free check. However, WC, WC-TP and 200 *T. portulacastrum*/m^2 caused more reduction than other *T. portulacastrum* densities and were comparable with each other. Soybean crop growth rate (CGR) (Fig. 2a), leaf area index (LAI) (Fig. 2a), relative growth rate (RGR) (Fig. 2b) and net assimilation rate (NAR) (Fig. 2b) too differed significantly. Soybean registered the highest CGR, RGR, NAR and LAI under WFC, and there was significant reduction of these

Table 3. Pods/plant, seeds/pod, seeds/plant, seed weight/plant (g) and test (1000-seed) weight (g) of soybean across the treatments

Treatments	Pods/plant	Seeds/pod	Seeds/plant	Seed weight /plant	Test weight (g)
All weeds including TP/weedy check (WC)	65.3	1.9	124.1	13.96	112.6
All weeds excluding TP (WC-TP)	84.7	1.9	163.8	12.33	117.6
25 TP/m^2	107.0	2.3	249.7	19.67	118.8
50 TP/m^2	100.7	2.1	215.0	19.00	116.6
75 TP/m^2	87.0	2.1	186.0	16.33	118.1
100 TP/m^2	68.7	2.0	136.3	13.67	111.8
200 TP/m^2	69.0	1.9	133.1	13.00	112.6
Weed-free check (WFC)	153.3	2.3	357.7	26.65	124.7
LSD (P=0.05)	25.85	0.22	26.25	3.062	9.62

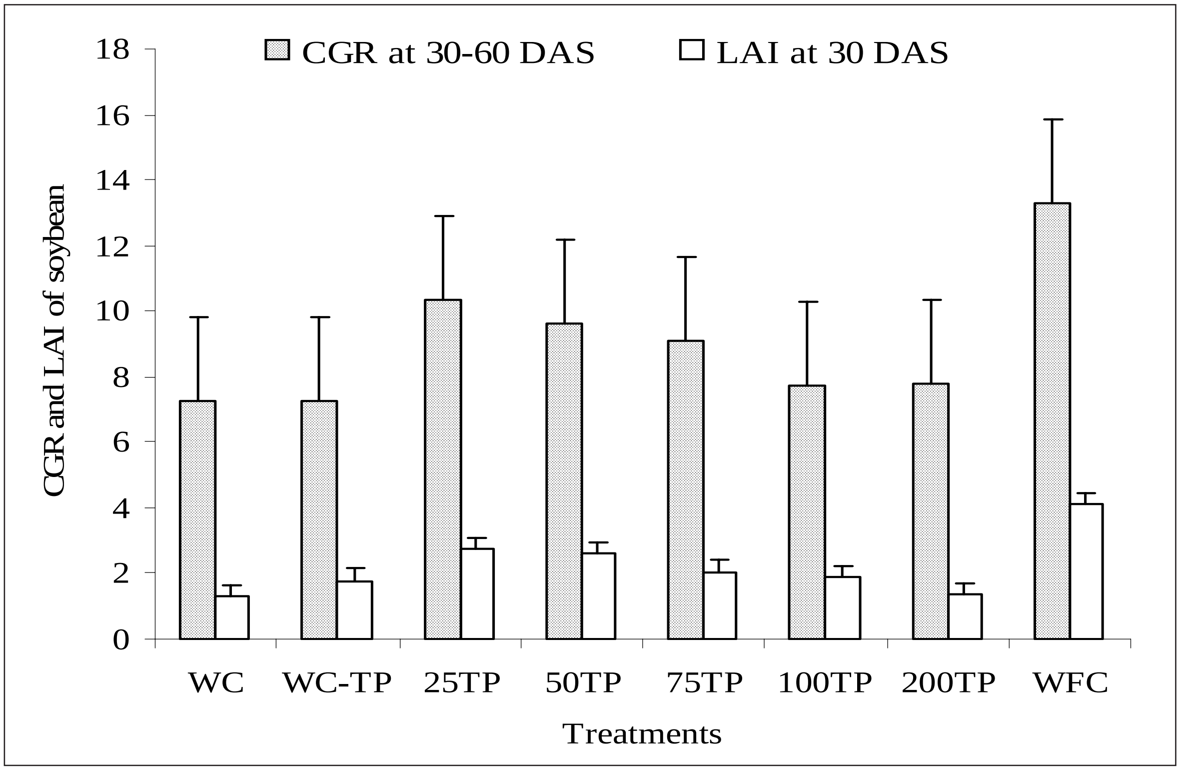

Fig. 2a. Crop growth rate (g/m²/day) and leaf area index (LAI) of soybean.

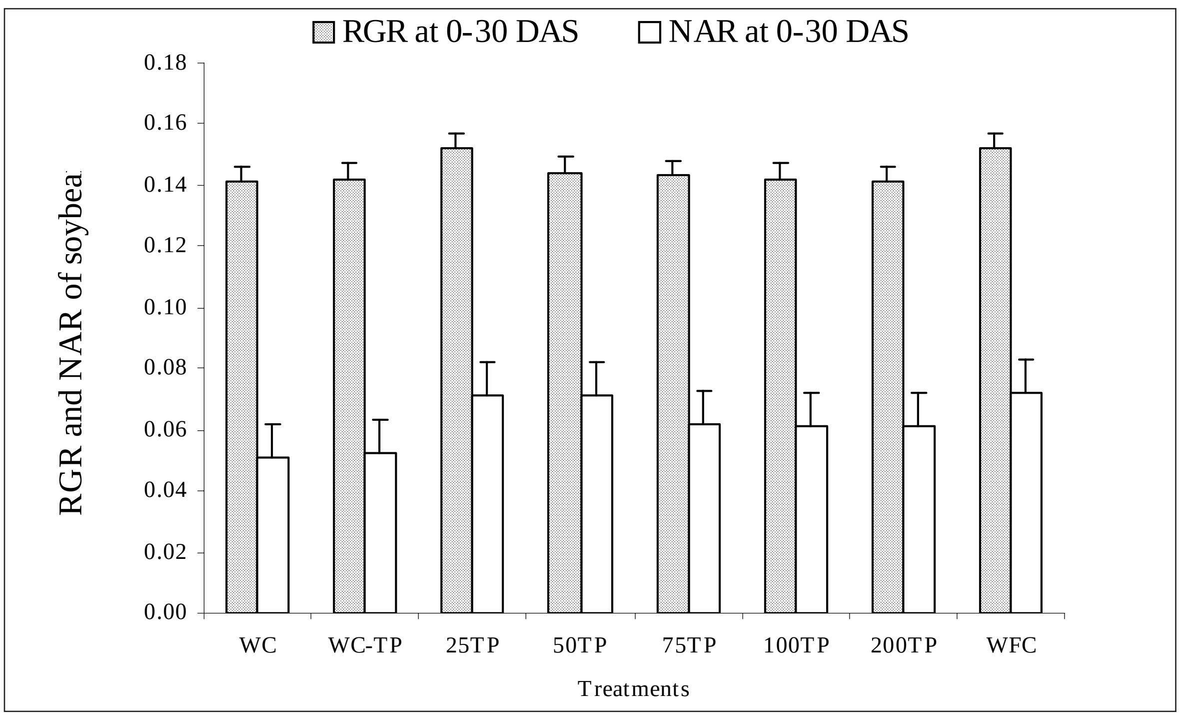

Fig. 2b. Relative growth rate (g/g/day) and net assimilation rate (g/m²/day) of soybean.

physiological parameters in the WC, WC-TP, 200, 100 and 75 *T. portulacastrum*/m^2 than in WFC or other lower *T. portulacastrum* densities. The WC caused the greatest reduction in the pods/plant, seeds/pod, seeds/plant and seed weight/plant of soybean (Table 3). The 200 and 100 *T. portulacastrum*/m^2 were comparable with it for all these attributes and the WC-*T. portulacastrum* for seeds/pod and seed weight/plant. The ultimate reflection of weed competition takes place on the yield of a crop. WC resulted in significantly lower soybean seed yield (Fig. 3), and 200, 100 and 75 *T. portulacastrum*/m^2 and WC-TP inflicted comparable reduction in seed yield as the WC. This exhibited variation in the competition across treatments with highest weed competition under WC and 200 *T. portulacastrum*/m^2. Several workers (Regnier and Stoller, 1989; Ponnuswamy *et al.*, 1996; Chhokar *et al.*, 1997) have reported similar results. Probable reasons have been discussed in the former section. This was again corroborated from the significant negative correlations (at $P \leq 0.01$) between soybean parameters (seed yield, dry weight, leaf area, pods/plant and seeds/plant) and TP density (Table 2).The yield reductions are generally in proportion to the amount of light, water or nutrients weeds use at the expense of a crop (Zimdahl, 1980).

Uptake of N, P and K by Soybean

First 60 days is delineated as critical period for weed competition in soybean (Muniyappa et al., 1982). Weed competition is severe during this period in soybean. Besides, *T. portulacastrum* grows for a period of 65-70 days. Having an exclusive vegetative growth for the initial 30-35 days, its both vegetative and reproductive growths continue till 60-65 days, when it reaches to senescence (Singh and Kolar, 1994). Therefore, an attempt was made to determine the uptake of N, P and K by soybean at 60 DAS (Table 4). There was significant negative correlation (at $P \leq 0.01$) between the uptakes of N, P and K by

Table 4. Uptake of N, P and K (kg/ha) by soybean at 60 DAS

Treatments	N	P	K
All weeds including TP/weedy check (WC)	69.8	6.6	14.8
All weeds excluding TP (WC-TP)	70.7	7.3	15.4
25 TP/m^2	99.4	13.3	25.9
50 TP/m^2	91.6	12.3	22.8
75 TP/m^2	86.0	11.3	20.4
100 TP/m^2	75.2	9.4	17.1
200 TP/m^2	74.0	8.1	16.7
Weed-free check (WFC)	126.4	17	33.3
LSD (P = 0.05)	21.04	2.03	4.99

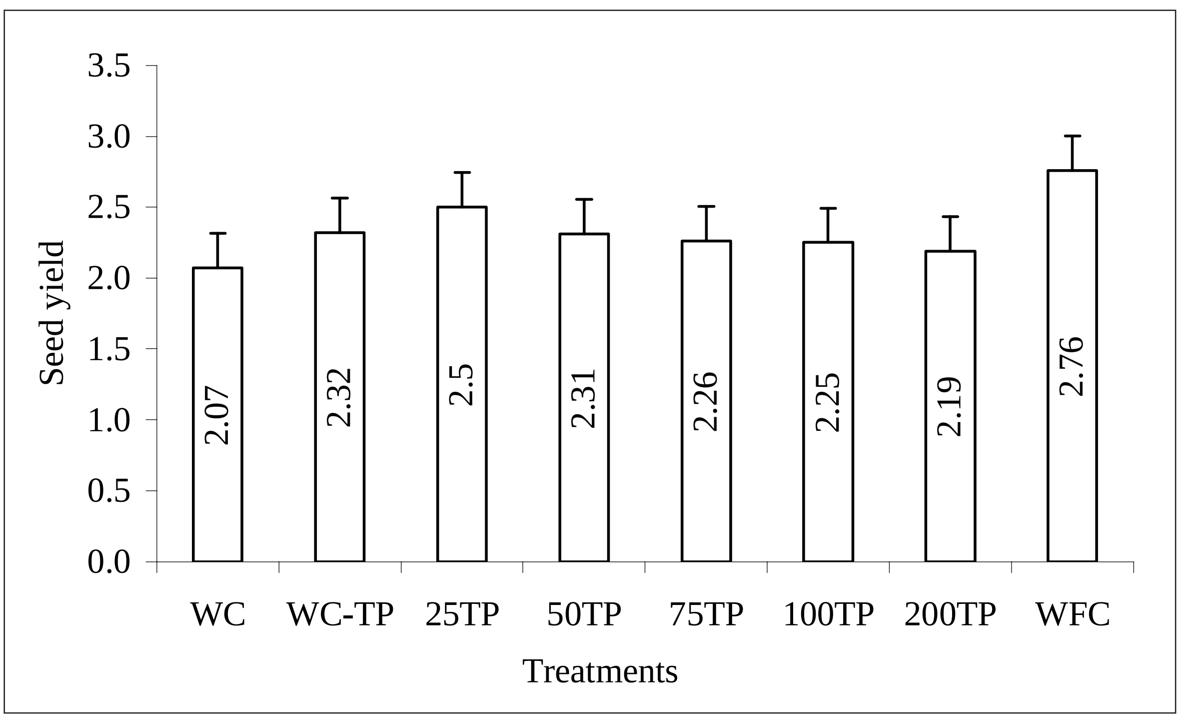

Fig. 3. Soybean seed yield (t/ha) across the treatments.

soybean and the *T. portulacastrum* density. The uptakes decreased gradually with increase in *T. portulacastrum* density. The WC, WC-TP and all *T. portulacastrum* densities resulted in significantly lower uptake of N, P and K by soybean compared to WFC (Table 4). Even the lowest density of 25 *T. portulacastrum*/m^2 proved inhibitive to soybean towards uptake of these nutrients. The WC, WC-TP and 200 *T. portulacastrum*/m^2, brought about more reduction in the uptake of these nutrients by soybean due to greater competition with soybean than others.

REFERENCES

Akobundu, I. O. 1987. *Weed Science in the Tropics : Principles and Practices.* New York : John Wiley & Sons. 522 p.

Arya, M. P. S. 1995. Distribution pattern of **kharif** season weeds in U. P. hills. *Ind. J. Weed Sci.* **27** : 56-62.

Chhokar, R. S., R. S. Balyan and S. S. Pahuja, 1997. Nutrient removal of weeds in soybean under integrated weed management. *Ind. J. Agron.* **42** : 138-141.

Cousens, R. 1987. Theory and reality of weed control thresholds. *Plant Prot. Q.* **2** : 13-20.

Cussans, G. W., R. Cousens and B. J. Wilson, 1986. Thresholds for weed control–The concepts and their interpretation. In : Proc. European Weed Research Society (EWRS) Symp.-Economic Weed Control. pp. 253-260. Stuttagart-Hohenheim, Germany : EWRS.

Das, T. K. 2001. Towards better appraisal of herbicide bio-efficacy. *Ind. J. agric. Sci.* **71** : 676-678.

Das, T. K. 2008. *Weed Science : Basics and Applications.* Jain Brothers Publishers, New Delhi, India. 901 p.

Das, T. K. and N. T. Yaduraju, 1996. Crop-weed competition studies in some **kharif** crops. Part I. Physiological parameters. *Ind. J. agric. Res.* **30** : 235-241.

Jackson, M. L. 1973. *Soil Chemical Analysis.* Englewood Cliffs, USA : Prentice Hall, Inc.

Muniyappa, T. V., T. V. R. Prasad and K. Krishnamurthy, 1982. Critical stages of crop-weed competition and chemical weed control in soybean (*Glycine max* L.). In : *Abstracts of Papers, Annual Conf.* Indian Society of Weed Science, December 27-30, p. 15.

Ponnuswamy, K., R. Jagannathan, O. S. Kandaswami and Bala Subramaniam,1996. Critical period of weed competition in soybean. *Madras agric. J.* **83** : 469-470.

Regnier, E. E. and E. W. Stoller, 1989. The effects of soybean, jimson weed and velvet leaf. *Weed Sci.* **37** : 187-195.

Sharma, R. S., M. L. Kewat and K. K. Jain, 1995. Identification of problematic weeds in Jabalpur region of Madhya Pradesh. *Ind. J. Weed Sci.* **27** : 19-23.

Singh, Chhidda, 1996. *Modern Techniques of Raising Field Crops.* Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India. 523 p.

Singh, H. and J. S. Kolar, 1994. Crop-weed competition studies in soybean. *Ind. J. Weed Sci.* **26** : 83-86.

Zimdahl, R. L. 1980. *Weed-Crop Competition* : *A Review.* Corvallis (OR) : International Plant Protection Center, Oregon State University. 196 p.