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Nutrient uptake by sunflower (*Helianthus annuus*) and associated weeds during rainy season

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ABSTRACT

A field experiment on the effect of crop–weed competition on nutrient uptake by rainy-season sunflower (*Helianthus annuus* L.) and associated weeds was carried out during 1995 and 1996 at New Delhi. Nutrient concentration (N, P and K) in weeds was greater at younger stages (30 and 45 days after sowing) and decreased towards maturity. Weed-free condition enhanced N and P content in sunflower seeds and K in stalk, while presence of weeds decreased it. Weeds under the unweeded control treatment removed 48.2, 14.4 and 53.5 kg of N, P and K/ha, out of which 63.2, 56.7 and 59.1%, respectively, was jointly removed by *Trianthema portulacastrum* L. and *Digera arvensis* Forsk. Season-long weed-free crop could remove 125.8 kg N, 51.2 kg P and 125.6 K/ha which were 54.3, 49.9 and 55.9% more as compared to nutrient removal by crop under weedy check treatment.

Key words : Sunflower, Nutrient uptake, Nitrogen, Phosphorus, Potassium

Axiomatically competition for nutrients constitutes an important aspect of crop–weed competition in limiting the yield of sunflower (*Helianthus annuus* L.). Weeds usually absorb mineral nutrients faster than many of the crop plants and accumulate them in their tissues in relatively larger amount (Mukhopadhyay, 1974; Mani, 1975). Among the plant nutrients, nitrogen, phosphorus and potassium are the limiting ones. Hence control of weeds is very important not only to check the losses, but also to increase the efficiency of the applied nutrients. The present investigation was therefore carried out to assess the extent of nutrient depletion by sunflower and associated weeds under different crop–weed competition environments.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season of 1995 and 1996, at the Indian Agricultural Research Institute, New Delhi. The soil was medium

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in available nitrogen (448.2 kg/ha), phosphorus (17.4 kg/ha) and potassium (208.0 kg/ha). The soil was slightly alkaline in reaction and non-saline (pH 8.2), with electrical conductivity 0.35 dS/m. The organic carbon content was 0.56%. The recommended dose of 60 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha through urea, single superphosphate and muriate of potash, respectively, was uniformly applied. However, 50% of the nitrogen was given 25 days after sowing. The experiment was laid out in randomized block design with 3 replications. Ten treatments comprised weed-free period for the first 15, 30, 45, 60 days after sowing and up to harvest (weed-free check) and weed infestation for the first 15, 30, 45, 60 days after sowing and up to harvest (unweeded control). Sunflower (cv. 'MSFH 8') was sown @ 10 kg/ha at the spacing of 60 cm × 30 cm.

Nitrogen, phosphorus and potassium contents in crop and weeds were determined by modified Kjeldahls method, vanadomolybdate phosphoric acid yellow colour method and flame photometer respectively (Jackson, 1973). Nutrient uptake by weeds was recorded at the completion of each treatment, i.e. for weed-free treatments at harvest and for weed-infestation treatments 15, 30, 45, 60 days after sowing and at harvest accordingly. The data were pooled over the years in respect of weeds and crop.

RESULTS AND DISCUSSION

The weed flora mainly comprised *Trianthema portulacastrum* L., *Digera arvensis* Forsk, *Cyperus rotundus* L., *Acrachne racemosa* Ohuy and *Dactyloctenium aegyptium* Beauv. The other weeds of minor importance were *Digitaria sanguinalis* Scop, *Echinochloa colonum* Link, *Eragrostis tenella* Beauv. *Tribulus terrestris* L. and *Commelina benghalensis* L.

Nutrient content

The nutrient concentration (N, P and K) in weeds were maximum during younger stages (at 30 and 45 days) in almost all weeds and decreased at subsequent stages (Table 1). Similar phenomenon was also recorded by Vengris *et al.* (1955). The N content was maximum in *D. arvensis*, followed by *D. aegyptium*, *T. portulacastrum*, *C. rotundus* and *A. racemosa* (Table 1). Maximum P was accumulated in *T. portulacastrum*, followed by *D. arvensis*, *A. racemosa*, *D. aegyptium* and *C. rotundus*. Nevertheless, K content was greater in *D. aegyptium*, followed by *A. racemosa* which was equivalent with *T. portulacastrum* and *D. arvensis*. However, *C. rotundus* recorded lowest value.

The different treatments significantly influenced N and P content in sunflower seeds and K content in stalk (Table 2). The maximum value was obtained with weed-free check and weed infestation only up to 15 days. The possible reason for accumulation of nutrients in weed-free crop could be the availability of these nutrients only to the crop due to less crop–weed competition.

Nutrient uptake by weeds

Almost all weeds showed gradual increase in nutrient uptake till harvest, except *T. portulacastrum* in which there

Table 1. Nitrogen, phosphorus and potassium content (%) in different dominant weeds at different stages (mean data of 2 years)

Weed species	Nutrient	Days after sowing				
		15	30	45	60	At harvest
Trianthema portulacastrum	N	2.50	2.69	2.35	2.28	2.27
	P	0.70	1.05	0.66	0.63	0.58
	K	2.50	2.65	2.75	2.65	2.41
Digera arvensis	N	3.25	3.87	3.05	2.75	2.48
	P	0.82	0.95	0.67	0.65	0.60
	K	2.45	2.65	2.73	2.50	2.52
Cyperus rotundus	N	1.77	1.88	1.90	1.87	1.81
	P	1.50	0.77	0.61	0.61	0.60
	K	2.16	2.35	2.56	2.15	2.20
Acrachne racemosa	N		1.70	1.84	1.72	1.45
	P		0.81	0.91	0.78	0.50
	K		2.65	2.76	2.30	2.15
Dactyloctenium aegyptium	N		2.54	2.78	2.45	2.10
	P		0.79	0.84	0.80	0.55
	K		2.48	3.05	2.40	2.16

Table 2. Effect of weed-free and weedy periods on nutrient content (%) at harvest in stalk and seeds of rainy-season sunflower (mean data of 2 years)

Treatment	Nitrogen		Phosphorus		Potassium	
	Seeds	Stalk	Seeds	Stalk	Stalk	Stalk
Weed-free up to 15 days*	2.52	1.26	0.77	0.61	0.70	1.67
Weed-free up to 30 days	2.68	1.29	0.79	0.59	0.80	1.70
Weed-free up to 45 days	2.76	1.30	0.80	0.60	0.85	1.75
Weed-free up to 60 days	2.78	1.25	0.82	0.60	0.85	1.75
Weed-free check	2.81	1.28	0.82	0.61	0.85	1.80
Weed infestation up to 15 days	2.75	1.24	0.80	0.59	0.82	1.80
Weed infestation up to 30 days	2.73	1.32	0.79	0.57	0.75	1.77
Weed infestation up to 45 days	2.61	1.31	0.77	0.62	0.70	1.72
Weed infestation up to 60 days	2.53	1.28	0.76	0.64	0.65	1.68
Unweeded control	2.52	1.31	0.75	0.68	0.68	1.66
CD (P=0.05)	0.21	NS	0.03	NS	NS	0.06

*Days after sowing

Table 3. Effect of weed-free and weedy periods on nutrient uptake by different weeds during rainy-season (mean data of 2 years)

Treatment	N uptake (kg/ha)					
	A	B	C	D	E	Total$^{\Psi}$
WF up to 15 days*	13.67	14.55	7.24	4.49	2.70	43.63
WF up to 30 days*	5.18	5.65	3.56	1.56	0.99	17.80
WF up to 45 days*	1.82	4.08	3.38	0.00	0	10.09
WF up to 60 days*	0.95	1.90	1.61	0	0	4.72
Weed-free check	0	0	0	0	0	0
WF up to 15 days*	4.30	1.04	0.97	0.00	0	6.62
WI up to 30 days*	8.68	9.68	3.70	2.45	1.44	26.50
WI up to 45 days*	14.33	14.49	5.53	3.57	1.95	40.97
WI up to 60 days*	15.74	15.21	6.50	4.02	2.86	46.16
Unweeded control	14.85	15.61	7.21	4.20	3.71	48.17
CD (P=0.05)	1.84	1.49	0.95	0.50	0.47	5.80
			P uptake (kg/ha)			
WF up to 15 days*	3.08	3.96	2.17	1.71	0.59	11.77
WF up to 30 days*	1.27	1.46	0.92	0.37	0.21	4.25
WF up to 45 days*	0.40	1.11	0.72	0	0	2.44
WF up to 60 days*	0.16	0.48	0.36	0	0	1.09
Weed-free check	0	0	0	0	0	0
WF up to 15 days*	1.21	0.26	0.27	0	0	1.73
WI up to 30 days*	3.39	2.50	1.52	1.03	0.45	9.12
WI up to 45 days*	3.97	3.09	1.89	1.76	0.58	11.45
WI up to 60 days*	4.33	3.87	2.09	1.81	0.94	13.63
Unweeded control	3.75	4.41	2.39	1.90	1.00	14.40
CD (P=0.05)	0.86	0.68	0.53	0.46	0.35	2.58
			K uptake (kg/ha)			
WF up to 15 days*	14.50	15.18	8.51	5.57	2.77	47.57
WF up to 30 days*	5.76	5.78	4.20	1.89	0.94	19.50
WF up to 45 days*	1.98	4.17	3.64	0	0	10.64
WF up to 60 days*	0.97	1.92	1.69	0	0	4.90
Weed-free check	0	0	0	0	0	0
WF up to 15 days*	4.30	0.57	1.16	0	0	6.50
WI up to 30 days*	8.51	6.64	4.68	3.85	1.41	25.90
WI up to 45 days*	16.77	13.07	7.43	5.35	2.14	46.39
WI up to 60 days*	18.34	14.84	8.48	6.16	2.83	50.98
Unweeded control	15.64	16.00	8.77	6.63	3.80	53.53
CD (P=0.05)	2.73	2.16	1.19	1.28	0.95	5.05

WF, Weed-free; WI, weed infestation; days* after sowing; Ψalso includes other weed species.

A, *Trianthema portulacastrum;* B, *Digera arvensis*; C, *Cyperus rotundus*; D, *Acrachne racemosa*; E. *Dactyloctenium aegyptiam*

was decline at harvest. The *T. portulacastrum* emerged along with crop seedling, developed rapidly and posed a severe competition to the crop during early periods. Among dominant weed species, *T. portulacastrum* and *D. arvensis* were most predominant and jointly removed about 63.2% N, 56.7% P and 59.1% K under weedy check treatment. It was mainly because of greater accumulation of dry matter by these dominant weeds. Weeds removed 48.17, 14.40 and 53.53 kg/ha N, P and K, respectively, under unweeded control treatment that was significantly higher over rest of the treatments. Nevertheless, when weed growth was not interrupted 85.1% N, 79.5% P and 86.7% K uptake (as compared to unweeded control) by weeds was garnered by the day 45 of sowing. The every increase in weed-free period significantly reduced the uptake of N, P and K by dominant weed species.

Nutrient uptake by crop

Crop with season-long weed-free condition derived maximum amount of N, P and K which were 54.3, 50.0 and 56.0%) respectively more than the uptake by crop with season-long weed infestation (Table 4). This could be because of higher nutrient content and higher dry-matter production under weed-free check treatment. However, crop initially weed-free for the first 45 days removed 90.3% N, 89.2% P, and 88.6% K of their total uptake by crop with season-long weed-free condition. Therefore, keeping crop initially weed-free is of prime importance because weed-free condition favoured the crop growth, which eventually helped garner greater amount of nutrients (Vengris *et al.*, 1955). Crop with weed-free condition throughout season could save 68.4, 25.6 and 65.4 kg of N, P and K/ha respectively. In contrast, under weed-infestation treatments crop was deprived from the uptake of nutrients that ultimately

Table 4. Effect of different weed-free and weedy periods on crop parameters, yield and nutrient uptake at harvest by rainy-season sunflower (mean data of 2 years)

Treatment	Plant height (cm)	Dry-matter accumulation (g/plant)	Yield (q/ha)	Nutrient uptake (kg/ha)		
				Nitrogen	Phosphorus	Potassium
WF up to 15 days*	145.1	64.6	8.69	65.84	27.98	64.53
WF up to 30 days*	152.1	85.2	12.48	94.16	37.52	90.42
WF up to 45 days*	153.4	101.6	14.58	113.66	45.77	111.36
WF up to 60 days*	156.7	112.6	16.25	121.21	50.00	120.56
Weed-free check	157.4	114.8	16.69	125.83	51.26	125.63
WI up to 15 days*	156.0	106.8	16.07	118.88	48.51	115.77
WI up to 30 days*	150.4	81.6	12.20	93.80	36.07	91.57
WI up to 45 days*	148.2	67.5	9.30	70.90	30.07	34.82
WI up to 60 days*	142.9	59.1	8.25	62.49	27.10	60.26
Unweeded Control	141.8	58.2	7.57	57.46	25.66	55.30
CD (P=0.05)	4.01	7.31	1.65	7.61	4.96	9.42

WF, Weed-free; WI, weed infestation; *days after sowing

reduced the yield. There was an inverse relationship between the nutrient uptake by crop and weeds when both were subjected to identical treatments. Similar findings also reported by Girijesh and Patil (1989).

Crop parameters and yield

The different weedy and weed-free treatments markedly influenced the plant height, dry-matter production and yield of sunflower. There was an increase in these crop parameters with the increase in weed-free period. Thus, the crops under weed-free check treatment recorded maximum plant height and dry-matter accumulation. The presence of weeds caused drastic reduction in dry-matter production that ultimately declined the seed yield. The magnitude of reduction in seed yield due to weeds during 15–30 days after sowing was more than that of either during first 15 days or during later stages. Seed yield loss increased with the increase in the duration of competition and maximum loss of 54.6% occurred due to full-season competition.

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