The Bioscan 11(3): 1667-1670, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF INTEGRATED WEED MANAGEMENT PRACTICES ON NUTRIENT CONTENT AND UPTAKE BY SAFFLOWER AND ITS ASSOCIATED WEED, WEED FLORA, YIELD AND HARVEST INDEX

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KEYWORDS
Safflower
nutrient content
uptake
weed flora

Received on :
26.03.2016

Accepted on :
28.07.2016

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ABSTRACT
A field experiment was conducted at the Instructional cum Research Farm, IGKV, Raipur during rabi season of 2013-14 to know the effect of integrated weed management practices on the nutrient content and uptake by crop, associated weed and on yield of crop. The result show that the weeds when allowed till harvest depleted 19.47 kg N, 0.60 kg P, 9.24 kg K, ha^{-1}. Among the integrated methods, Treatment Pendimethalin 30 EC @ 1 kg ha^{-1} + 2 hand hoeing at 25 and 45 DAS (T_8) recorded significantly higher nutrient uptake by crop (144.76 kg N, 10.21 kg P, 50.19 kg K) ha^{-1} and lower uptake by weeds (1.17 kg N ,0.05kg P, 0.82 kg K ha^{-1}) and higher seed yield (1212.4 kg ha^{-1}) and stover yield (3214.2 kg ha^{-1}) of safflower. The data reveal that there was no significant variation on harvest index due to the weed-crop competition. The percentage composition of *Medicago denticulata* (69.74%, 84.67%, 88.60%, 86.43% and 85.25%) was recorded highest as compare to other weed flora.

INTRODUCTION

Oilseed crops grown in India in about 37.18 million hactares and annual production is about 36.07 million tonnes. USDA 2014. India has the largest area in the world under oilseed crops, but the average yields are barely 970 kg ha^{-1}. Safflower (*Carthamus tinctorius* L.) is one of the world's oldest crops (Vargas *et al*., 2008).Evidence of seeds and dyes from Carthamus has been found in Egyptian tombs, along with pictographic representations (Hallman, 2008).Plants are 30-150 cm tall with globular flower heads (capitula).The plant has a strong taproot which enables it to thrive in dry climates. In India, the crop has traditionally been grown in the '*rabi*' or winter dry season in mixture with other '*rabi*' crops, such as wheat and sorghum. In India, it occupies 1.5 lakh ha area, 1.09 lakh t production and 726.7 kg ha^{-1} productivity (FAO, 2013). The poor weed management practices deprive the crop of its major requirement of nutrients, soil moisture, sunlight and space which results poor crop growth and yield. (Kumar *et al.*,2014). Jalali *et al.* (2012) observed that predominant weed flora associated with the safflower crop was bindweed (*Convolvulus arvensis L.*),common lambsquarters (*Chenopodium album* L.), camel thorn (*Alhagi camelorum* L.), and common cocklebur (*Xanthium strumarium*). Uncontrolled weed growth caused enormous loss of nutrient which in turn reduced the yield of sunflower crop upto an extent of 64% (Legha *et al.*,1992). Integrated weed management, defined as the combination of two or more weed-control methods at low input levels to reduce weed competition in a given cropping system below an economical threshold level (Verma *et al.*,2015).To reduce the loss of nutrient due to weeds and increase the yield of safflower the present investigation was carried out to know the effect of integrated weed management practices on nutrient content and uptake by safflower and weeds

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2013-14 at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) The soil of the experimental site was sandy loam in nature and locally known as 'Matasi'. It is low in available nitrogen (211.40 kg ha^{-1}N) and medium in phosphorus and potassium content., (18.40 kg ha^{-1}P) (203.84 kg ha^{-1}K) with pH of 7.3. The experiment was laid out in Randomized Block Design with three replications. There were fourteen treatment combinations comprised of pre- and post emergence application of different herbicide molecules either alone or in combination with one and two hand hoeing and unweeded check. The recommended dose of fertilizer Recommended dose of nutrient was 90 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1}. The whole quantity of P and K was applied as basal dressing, while nitrogen was applied in two splits viz. 45 kg N ha^{-1} as basal and remaining 45 kg N in 45 DAS. The oven-dried (60ºC) samples of weed and crops at harvest were analyzed for nutrient content. Nitrogen was estimated by Microkjeldal method (Piper 1966), Phosphorus was estimated by Olsen's method (Olsen 1954), and Potassium was estimated with the help of Flame photometric method (Jackson, 1967). The nutrient uptake by crop and its associated weeds were determined by multiplying the percent nitrogen, phosphorus and potassium content in the plant with their respective dry weights at harvest. The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1984).

Harvest index (%) (Donald, 1962)

$$\text{Harvest index}(\%) = \frac{\text{Grain yield}}{\text{Biological yield(grain + straw)}} X100$$

Weed flora composition

$$\text{Weed folra composition} \frac{\text{Dry weight of a weed species in a community}}{\text{Dry weight of all weed species in a community}} X100$$

Weed growth rate (g day^{-1}m^{-2}) (Mishra,R.1968)

$$\text{Weed growth rate}(g\ day^{-1}m^{-2}) = \frac{w_2 - w_1}{t_2 - t_1}$$

Where;W_2 - W_1 = Difference in oven dry biomass at the interval

t_2 - t_1 = time interval in days

RESULTS AND DISCUSSION

Effect on Weed flora composition (%)

At 25,50,75,100 DAS and at harvest, the percentage composition of *Medicago denticulata* (69.74%, 84.67%, 88.60%, 86.43% and 85.25%) was recorded highest followed by *Cyperus iria* (16.46%, 8.50%, 4.48%, 5.26% and 5.61%, respectively) Table.1.

Other weed species like *Medilotus indica, Cynodon dactylon* etc. were also observed in the experiment field in negligible quantum.

Effect on weed growth rate (g day^{-1} m^{-2})

Data on weed growth rate during various crop growth intervals are presented in Table2. which indicate that weed growth rate showed increasing trend upto 50-75 DAS and decreasing trend thereafter. Throughout the crop growth period, among the integrated weed management practices Pendimethalin 30 EC @ 1 kg ha^{-1} and two hand hoeing (T_8) registered significantly lowest weed growth rate except at 50-75 DAS whereas, highest weed growth rate was recorded under control plot (T_{14}). These results might be due to more accumulation of photosynthates by weeds and increase in density of weeds. Similar results were obtained by Jaya kumar *et al.* (1989), Kori *et al.* (1997), Malligawad *et al.* (2000), Madhu *et al.*(2006), Kumare *et al.* (2007) and Dalavai *et al.* (2008)

Nutrient content and uptake by crop

The data related to Nitrogen, Phosphorus, Potassium content and uptake by seed, stover and their total by safflower crop are presented in Table 3. Significant difference was found between the different integrated weed management practices. Significantly the highest nitrogen phosphorus, potassium content and uptake by seed, stover and their total was obtained under Pendimethalin 30 EC @ 1 kg ha^{-1} + 2 hand hoeing at 25 and 45 DAS (T_8). The mean uptake of nitrogen Phosphorus, potassium by crop was in unweeded check was 38.32, 3.14, 17.06 kg ha^{-1} whereas in treatment Pendimethalin 30 EC @ 1 kg ha^{-1} + 2 hand hoeing at 25 and 45 DAS (T_8) it was 144.76, 10.21, 50.19 kg ha^{-1}, respectiveiy. This indicates that these

Table 1 : Weed flora composition (%) at different duration of Safflower plant

	Weed species	Weed flora composition (%)				
		25 DAS	50 DAS	75DAS	100 DAS	At Harvest
1	*Medicago denticulata*	69.74	84.67	88.6	86.43	85.25
2	*Chenopodium album*	6.22	1.97	4.24	4.56	5.44
3	*Cyperus iria*	16.46	8.5	4.48	5.26	5.61
4	Others	7.58	4.86	2.67	3.75	3.7

Table 2 : Effect of integrated weed management practices on weed growth rate (g day^{-1} m^{-2}) at different duration of safflower plant

	Treatment	Dose (g ha^{-1})	Time of DAS application	Weed growth rate (g day^{-1} m^{-2}) 25-50 DAS	50-75 DAS	75-100 DAS	100 DAS – At harvest
T_1	Oxyflourfen	250	PE	0.49	2.39	0.52	-0.16
T_2	Pendimethalin30 EC	1000	PE	0.48	2.01	0.55	-0.17
T_3	Pendimethalin 37.8 EC	1000	PE	0.49	2.13	0.53	-0.11
T_4	T1 + 1hand hoeing	250	PE+ 25	0.26	0.99	0.44	-0.18
T_5	T2 + 1hand hoeing	1000	PE+ 25	0.2	0.57	0.38	-0.15
T_6	T3 + 1hand hoeing	1000	PE+ 25	0.21	0.81	0.37	-0.15
T_7	T1 + 2 hand hoeing	250	PE+ 25&45	0.07	0.12	0.1	-0.02
T_8	T2 + 2 hand hoeing	1000	PE+ 25&45	0.06	0.13	0.06	-0.02
T_9	T3 + 2 hand hoeing	1000	PE+ 25&45	0.06	0.13	0.08	-0.02
T_{10}	Hand hoeing		25&45	-0.23	0.12	0.09	-0.02
T_{11}	Metribuzin fb Metribuzin	175 fb 87.5	PE fb PoE	0.77	3.97	0.32	-0.24
T_{12}	Metribuzin fb Metribuzin	175 fb 31.25	PE fb PoE	1.08	4.1	0.37	-0.38
T_{13}	Pendimethalin fb Imazathapyr	1000 fb 40	PE fb PoE	0.58	2.44	0.25	-0.31
T_{14}	Control			1.73	4.02	0.62	-0.74

Table 3 : Nutrient content (%) and uptake (kg ha^{-1}) by seed, stover and their total as influenced by integrated weed management in safflower

	N content (%)		P content (%)		K content (%)		N uptake(kg ha^{-1})			P uptake(kg ha^{-1})			K uptake(kg ha^{-1})		
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
T_1	3.03	1.23	0.41	0.04	0.69	1.03	27.63	32.51	60.14	3.77	1.07	4.84	6.31	27.19	33.5
T_2	3.75	1.9	0.42	0.05	0.71	1.07	34.97	50.22	85.19	3.9	1.43	5.32	6.65	28.09	34.73
T_3	3.27	1.4	0.42	0.05	0.7	1.06	30.1	36.58	66.68	3.77	1.32	5.09	6.35	27.97	34.32
T_4	3.8	1.96	0.42	0.06	0.69	1.08	42.34	62.28	104.62	4.71	1.92	6.62	7.72	34.22	41.94
T_5	4.36	2.13	0.44	0.08	0.75	1.14	50.37	68.36	118.72	5.07	2.44	7.51	8.69	36.74	45.42
T_6	4.03	2.02	0.43	0.07	0.71	1.1	45.68	64.22	109.9	4.87	2.21	7.08	8.09	34.93	43.01
T_7	4.52	2.14	0.46	0.08	0.77	1.16	52.5	68.94	121.43	5.32	2.53	7.85	8.95	37.2	46.15
T_8	5.32	2.51	0.59	0.1	0.84	1.24	64.16	80.6	144.76	7.12	3.1	10.21	10.13	40.06	50.19
T_9	5.01	2.18	0.57	0.09	0.82	1.2	59.83	70.41	130.24	6.82	2.97	9.79	9.73	38.47	48.2
T_{10}	4.83	2.16	0.5	0.09	0.78	1.18	56.77	69.48	126.25	5.92	2.88	8.8	9.22	37.88	47.09
T_{11}	3.11	1.4	0.41	0.04	0.66	0.92	31.48	43.88	75.36	4.1	1.11	5.21	6.71	28.76	35.48
T_{12}	3.02	1.34	0.4	0.03	0.66	0.88	30.32	41.85	72.18	4.02	0.91	4.93	6.62	27.37	33.99
T_{13}	2.93	1.18	0.4	0.02	0.68	0.83	27.53	36.1	63.62	3.76	0.52	4.29	6.44	25.55	31.99
T_{14}	2.56	1.12	0.38	0.04	0.54	0.7	16.47	21.85	38.32	2.42	0.72	3.14	3.45	13.61	17.06
SEm ±	0.21	0.09	0.02	0.01	0.04	0.04	2.95	5.22	7.3	0.02	0.18	0.31	0.53	2.67	2.99
CD (P=0.05)	0.6	0.27	0.06	0.02	0.1	0.12	8.57	15.16	21.21	0.06	0.53	0.89	1.55	7.75	8.69

T_1- Oxyflourfen 250 g ha^{-1} PE; T_2- Pendimethalin 30 EC @ 1 kg ha^{-1} PE; T_3- Pendimethalin 37.8 EC @ 1 kg ha^{-1} PE; T_4- T_1 + 1hand hoeing at 25 DAS; T_5- T_2 + 1hand hoeing at 25 DAS; T_6- T_3 + 1hand hoeing at 25 DAS; T_7- T_1 + 2 hand hoeing at 25 and 45 DAS; T_8- T_2 + 2 hand hoeing at 25 and 45 DAS; T_9- T_3 + 2 hand hoeing at 25 and 45 DAS ; T_{10}- Hand hoeing at 25 and 45 DAS ; T_{11}- Metribuzin (PE) @ 175 g ha^{-1} fb Metribuzin (PoE) @ 87.5 g ha^{-1}; T_{12}-Metribuzin (PE) @ 175 g ha^{-1} fb Metribuzin (PoE) @ 31.25 g ha^{-1}; T_{13}-Pendimethalin (PE) @ 1 kg ha^{-1} fb Imazathapyr (PoE) @ 0.04 kg ha^{-1}; T_{14}- Control PE- Pre-emergence, PoE- Post-emergence, fb- Followed by

Table 4 : Nutrient content and uptake by weeds and yield and harvest index of safflower as influenced by integrated weed management practices

	Treatment	Dose (g ha^{-1})	Time of application (DAS)	Nutrient content (%) N	P	K	Nutrient uptake (kg ha^{-1}) N	P	K	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	HI (%)
T_1	Oxyflourfen	250	PE	1.86	0.08	1.06	7.76	0.34	4.39	910.8	2624.4	25.75
T_2	Pendimethalin30 EC	1000	PE	1.69	0.08	1.02	5.72	0.28	3.48	933.2	2643.4	26.33
T_3	Pendimethalin 37.8 EC	1000	PE	1.82	0.08	1.05	6.59	0.29	3.83	913.3	2624.8	25.65
T_4	T_1 + 1hand hoeing	250	PE+ 25	1.6	0.08	1.01	5.61	0.26	3.51	1120.8	3165.9	26.15
T_5	T_2 + 1hand hoeing	1000	PE+ 25	1.34	0.06	0.98	2.91	0.13	2.09	1150.7	3198.8	26.61
T_6	T_3 + 1hand hoeing	1000	PE+ 25	1.44	0.05	1	4.43	0.14	3.08	1131.1	3179.8	26.28
T_7	T_1 + 2 hand hoeing	250	PE+ 25&45	1.32	0.06	0.98	1.64	0.08	1.2	1161.4	3209	26.6
T_8	T_2 + 2 hand hoeing	1000	PE+ 25&45	1.03	0.04	0.73	1.17	0.05	0.82	1212.4	3214.2	27.36
T_9	T_3 + 2 hand hoeing	1000	PE+ 25&45	1.13	0.04	0.73	1.45	0.06	0.92	1198.3	3196.5	27.29
T_{10}	Hand hoeing			1.21	0.05	0.97	1.71	0.07	1.37	1176.4	3207	26.87
T_{11}	Metribuzin fb Metribuzin	175 fb 87.5	PE fb PoE	2	0.08	1.12	12.01	0.43	6.67	930.21	2612.39	26.52
T_{12}	Metribuzin fb Metribuzin	175 fb 31.25	PE fb PoE	2.05	0.08	1.08	12.72	0.5	6.62	915.31	2595.2	26.38
T_{13}	Pendimethalin fb Imazathapyr	1000 fb 40	PE fb PoE	2.07	0.08	1.07	13.66	0.54	6.96	911.41	2501.79	27.07
T_{14}	Control			2.36	0.08	1.14	19.47	0.6	9.24	635.8	1943.5	24.54
	SEm ±			0.09	0.01	0.06	1.76	0.03	0.73	59.06	210.28	1.02
	CD (P=0.05)			0.25	0.03	0.17	5.12	0.08	2.12	171.68	611.27	NS

treatments resulted in better control of early weeds in the crop and hence reduced the competition for nutrient, moisture and light. These had resulted in higher nutrient content and their uptake by the crop in the absence of crop-weed competition. Similarly, Jayakumar *et al.* (1989) and Kumara *et al.* (2007), findings also corroborates the present findings of higher NPK uptake by safflower due to herbicide and culture practices as compared to weedy check. These results are in conformity with the findings of Kori *et al.* (1997), Malligawad *et al.* (2000) and Madhu *et al.* (2006).

Nutrient content and uptake by weeds

The data on content and uptake of nitrogen, phosphorus, potassium by weeds as influenced by different integrated weed management practices in safflower are presented in Table 4. The data reveals that there was significant variation in nitrogen phosphorus, potassium content and uptake by weeds. Significantly the highest nitrogen phosphorus, potassium content and uptake of weeds was recorded in unweeded check (T_{14}). The lowest value was recorded under treatment Pendimethalin 30 EC @ 1 kg ha^{-1} + 2 hand hoeing at 25 and 45 DAS (T_8). The unweeded check removed 19.47 kg ha^{-1} N, 0.60 kg ha^{-1} P, 9.24 kg ha^{-1}K mainly because of more weed competition and higher weed dry matter more nutrients were uptake by the weed in weedy check as compared to herbicidal and hand hoeing treatment. Similar findings was observed by Jayakumar *et al.* (1989), Kori *et al.* (1997), Malligawad *el al.*(2000), Madhu *et al.* (2006) and Kumara *et al.* (2007).

Effect on yield and harvest index of safflower

Integrated weed management practices significantly influenced yield and harvest index of safflower. The data on harvest index as affected by different integrated weed management practices are presented in Table 4.The data reveal that there was no significant variation on harvest index due to the weed-crop competition. Significantly the higher seed yield (1212.4 kg ha^{-1}) and stover yield (3214.2 kg ha^{-1}) was recorded under the treatment of Pendimethalin 30 EC @ 1 kg ha^{-1} + 2 hand hoeing at 25 and 45 DAS (T_8) then rest of the weed management practices. The better performance of crop in (T_8) was mainly due to increased nutrient uptake and very low dry matter accumulation of weeds. Significantly higher seed and stover yield due to treatments resulted in better control of weeds and provided weed free condition for longer period of crop growth and resulted in increases of all growth and yield parameters as well as it might be due to effective control of weeds. All these parameters showed positive and significant influence on seed and stover yield of safflower, besides minimum depletion of nutrients by weeds and better uptake by crop, which might be cumulatively reflected in higher seed and stover yield of safflower, these findings are in close agreement with those reported by Nalayni *et al.* (1992) in sunflower, Singh and Giri (2011) in sunflower and groundnut and Parmar *et al.* (2014) in sunflower.

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