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Research Communication

Weed dynamics, yield and economics of winter transplanted organic chia (*Salvia hispanica* L.) under nutrient and weed management

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ABSTRACT

An experiment was conducted during winter (*rabi*) season of 2021–22 at Agricultural Research Station, Chhatabar, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be) University, Bhubaneswar, Odisha to study the effect of weed and nutrient management practices on weed dynamics, yield and economics of winter transplanted organic chia (*Salvia hispanica* L.). The experiment was conducted in split plot design having 6 weed and 5 nutrient management practices with three replications. Among 6 weed management practices, hoeing and weeding twice at 20 and 35 days after transplanting (DAT) recorded the minimum density and biomass of weeds with weed control efficiency of 85 and 79.4% at 40 DAT and harvest, respectively. *Nerium* leaf aqueous extract (NLAE) 5% + castor leaf aqueous extract (CLAE) 5% + manual weeding at 35 DAT proved equally effective in weed control. Hoeing and weeding twice with 9 t/ha FYM + green manuring + Jeevamrit gave the seed, oil and protein yield of 730, 204 and 145 kg/ha, as against 720, 205 and 136 kg/ha, respectively. Weed management by NLAE 5% + CLAE 5% + manual weeding integrated with 9 t/ha FYM + green manuring + Jeevamrit and both, being statistically at par, proved to be significantly superior to all other treatment combinations. These two treatment combinations recorded statistically similar net return and return per rupee investment, and proved significantly superior to all others.

***Key words*:** Gross return, Net return, Oil yield, Protein yield, Seed yield

Chia (*Salvia hispanica* L.), a nutraceutical oilseed, contains around 35% oil in seed of which the Omega-3 fatty acid is over 60%. Seeds are gluten free. Use of chia seeds prevents many cardiovascular diseases, diabetes and obesity. The demand of organic chia as health food is increasing nationally and globally. Weed and nutrient management are two important keys for realizing potential productivity of a crop. Use of plant extracts with allelopathic potential is a viable option for weed management in organic farming. Plant extracts alone or in combination with non-chemical methods may provide cost effective weed management in organic chia. Rajyalakshmi *et al*. (2011) and Al-Samarai *et al*. (2020) reported the allelopathic effect of *Nerium oleander* (L.) on *Parthenium* and *Cyperus rotundus,* respectively. Anwar *et al*. (2021) also reported allelopathic effect of castor leaf extract on *Parthenium hysterophorus*. Integration of green manures, crop residues and composts with liquid manures like *beejamrut, jeevamrit, panchgavya* and vermiwash etc. can release the nutrients in a more synchronized manner to meet phasic demand of the crop (Kanwar *et al.,* 2006). Gupta *et al*. (2006) reported 50% N substitution by sunn hemp (*Crotalaria juncea* L.) green manuring in rice-wheat system. Jeevamrit is unable to provide nutrients in needed quantity to the crops necessitating its use in combination with other sources (Aulakh *et al*., 2013). Keeping all these points in view, the present study was carried out to see the effect of nutrient and weed management on organic chia.

The experiment was conducted during winter (*rabi*) season of 2021–22 at Agricultural Research Station, Chhatabar (20° 15′ N and 85° 40′ E with an average altitude of 58 m amsl), Institute of Agricultural Sciences, Siksha

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'O' Anusandhan (Deemed to be) University, Bhubaneswar, Odisha to assess effect of nutrient and weed management on weed-flora and dynamics, productivity and economics of winter transplanted organic chia. The experiment consisted of 6 weed management practices, viz. W_1, Pre emergence application of *Nerium oleander* (L.) leaf aqueous extract 10% (NLAE 10%); W_2, Pre emergence application of *Ricinus communis* (L.) leaf aqueous extract 10% (CLAE 10%); W_3, Pre emergence application of NLAE 5% + CLAE 5% (NLAE 5% + CLAE 5%); W_4, NLAE 5% + CLAE 5% + manual weeding (MW) at 35 DAT (days after transplanting); W_5, Hoeing and weeding twice at 20 and 35 DAT; and W_6, Weedy check allocated to the main plots; and 5 nutrient management practices, viz. N_1, Recommended dose of nitrogen (60 kg/ha as FYM with 0.5% N) as FYM (farmyard manure); N_2, *In situ* green manuring of sunn hemp with 25 kg seed/ha (GM); N_3, green manuring + drenching soil with jeevamrit 5% at 15 days interval starting at transplanting till 75 DAT (GM + J); N_4, 50% RDN or 30 kg N/ha as FYM + green manuring + jeevamrit (FYM + GM + J); and N_5, 75% RDN or 45 kg N/ha as FYM + green manuring + jeevamrit (FYM + GM + J), allocated to the sub plots. The experiment was conducted in s split plot design with three replications. Chia cv. Chiampion B1 developed by CSIR-Central Food Technological Research Institute, Mysuru, Karnataka was taken as the test crop. Jeevamrit was prepared by using 1 kg cow dung, 1 litre cow urine, 200 g jaggery, 200 g chickpea flour and 100 g virgin soil (soil below forest trees). The final volumes of the mixtures were made to 20 litres with water in plastic containers. The mixtures were kept for incubation under shade for 5 days and stirred vigorously for 10–15 min 3-times a day with a wooden stick. Care was taken to store cow urine in plastic container and avoiding use of metal container. Cold water aqueous extracts were applied as directed spray at 1-week after planting by knapsack sprayer having flat fan nozzle and hood in the inter-row spaces to avoid injury to crop plants.

Ten weed species comprising of 4 grasses, viz. *Dactyloctenium aegyptium* (L.) Willd (crow-foot grass), *Cynodon dactylon* (L.) Pers. (Bermuda grass), *Eleusine indica* (L.) Gaertn. (goose grass) and *Digitaria sanguinalis* (L.) Scop. (large crab grass); and 6 broad-leaf weeds, viz. *Mitracarpus hirtus* (L.) DC. (tropical girdlepod), *Croton bonplandianus* Baill. (rustfoil), *Mimosa pudica* (L.) (sensitive plant), *Oldenlandia diffusa* (Willd.) Roxb (snake-needle grass), *Coldenia procumbens* (L.) (creeping coldenia) and *Parthenium hysterophorus* L. (wild carrot grass) were found in the experimental site. Among weed management practices, hoeing and weeding twice at 20 and 35 DAT recorded the minimum density and biomass of weeds (Fig. 1a and 1b). Pre-emergence application of NLAE 5% + CLAE 5% + manual weeding at 35 DAT was statistically at par in reducing density and dry weight of weeds. Other weed management practices based on leaf extract alone recorded significantly higher weed density and biomass than hoeing and weeding twice, but recorded significantly less weed density and biomass than weedy check. *Nerium* leaf extract was more effective than castor leaf extract in reducing density and biomass of weeds. Hoeing and weeding twice at critical period of crop weed competition helped in uprooting, desiccation and mortality of weeds leading to reduction in density and biomass. Supplementation of one hand weeding with pre-emergence application of NLAE 5% + CLAE 5% proved equally well. The weed species varied for susceptibility to *Nerium* or castor leaf extract. *Nerium oleander* has allelopathic substance rutin and quercetin, which affected germination of weed seeds. Rajyalaxmi *et al.* (2011) also reported adverse effect of *Nerium* on seed germination and shoot length of wild carrot grass.

Organic nutrient management practices influenced weed density and biomass significantly. Green manuring of sunn hemp and green manuring + Jeevamrit recorded less density and biomass of weeds. Green manuring crop suppressed weeds during the pre-cropping period compared to non-green manuring plots. Janwal *et al*. (2022) reported weed control efficiency of green manuring crops to the extent of 40–50% with the maximum efficiency for sunn hemp. Application of FYM @12 t/ha recorded higher density and biomass of weeds than 9 and 6 t/ha FYM. Sarapatka *et al*. (2012) also reported poorly decomposed FYM as a source of weed seed in soil.

Hoeing and weeding twice at 20 and 35 DAT proved to be the most effective among weed management practices with weed control efficiency (WCE) of 85.0 and 79.4% at 40 DAT and harvest (Table 1). Integration of manual weeding with NLAE 5% + CLAE 5% proved equally well. *Nerium* leaf extract based treatments recorded higher WCE than castor leaf extract based treatments. Weedy check reduced chia seed yield to the maximum extent with weed index (WI) of 34.9%. The three *Nerium* based weed management practices reduced yield loss due to weeds to a greater extent than castor leaf extract 10% alone. Superiority of hoeing and weeding twice and NLAE 5% + CLAE 5% + manual weeding at 35 DAT over other plant leaf extract based treatments was owing to selective control of weed species by leaf extracts and elimination of all species by hoeing and weeding, and manual weeding.

Weed and nutrient management practices acted synergistically to enhance seed, oil and protein yield (Table 2). The treatment combination of hoeing and weeding twice with 9 t FYM/ha + GM + Jeevamrit gave seed, oil and protein yield of 730, 204 and 145 kg/ha as against 720, 205

Table 1. Effect of weed management on weed control efficiency and weed index in organic chia

Treatment	Weed control efficiency (%)		Weed Index (%)
	40 DAT	Harvest	
W_1, NLAE 10%	65.5	65.8	10.0
W_2, CLAE 10%	42.1	43	22.0
W_3, NLAE 5% + CLAE 5%	73.7	76.8	12.3
W_4, NLAE 5% + CLAE 5% + MW at 35 DAT	84.5	78.1	9.1
W_5, Hoeing and weeding at 20 and 35 DAT	85	79.4	0.0
W_6, Weedy check	0	0	34.9

DAT, Days after transplanting.

Table 2. Effect of weed and nutrient management on yield of organic chia

Weed management	Nutrient management					
	N_1	N_2	N_3	N_4	N_5	Mean
Seed yield (kg/ha)						
W_1, NLAE 10%	666	261	414	401	594	467
W_2, CLAE 10%	500	198	342	401	572	402
W_3, NLAE 5% + CLAE 5%	455	243	437	464	675	455
W_4, NLAE 5% + CLAE 5% + MW	465	253	447	474	720	472
W_5, Hoeing and weeding twice	653	252	455	504	730	519
W_6, Weedy check	455	263	275	239	459	338
Mean	532	245	395	413	625	442
SEm±			W=13, N=4 , WN=15, NW=10			
CD (P=0.05)			W=40, N=11, WN=47, NW=27			
Oil yield (kg/ha)						
W_1, NLAE 10%	166	80	121	109	165	128
W_2, CLAE 10%	139	58	102	114	150	112
W_3, NLAE 5% + CLAE 5%	126	74	115	124	200	128
W_4, NLAE 5% + CLAE 5% + MW	125	76	135	146	205	137
W_5, Hoeing and weeding twice	179	72	129	139	204	145
W_6, Weedy check	121	79	81	71	139	98
Mean	159	73	125	127	193	135
SEm (±)			W=4, N=1, WN=5, NW=3			
CD (P=0.05)			W=13, N=3, WN=15, NW=8			
Protein yield (kg/ha)						
W_1, NLAE 10%	113	42	88	79	118	88
W_2, CLAE 10%	81	32	50	81	113	72
W_3, NLAE 5% + CLAE 5%	74	39	61	97	132	81
W_4, NLAE 5% + CLAE 5% + MW	77	42	94	92	136	88
W_5, Hoeing and weeding twice	111	41	97	99	145	98
W_6, Weedy check	74	42	38	50	89	59
Mean	88	40	71	83	122	81
SEm±			W=4, N=2, WN= 6, NW=5			
CD (P=0.05)			W=12, N=5, WN=17, NW=13			

MW, Manual weeding; HW, Hoeing and weeding; W, Weed management; N, Nutrient management; WN, W at same or different level of N; NW, N at same level of W.

and 136 kg/ha, respectively, in case of the combination NLAE 5% + CLAE 5% + manual weeding with the same nutrient management. Both combinations were statistically at par and proved significantly superior to all other combinations. Hoeing and weeding twice ensured weed free condition during critical period of crop weed competition and ultimately gave the maximum seed yield. Application of NLAE 5% + CLAE 5% provided broader spectrum weed control compared to CLAE 10%. Further supplementing manual weeding at 35 DAT further improved seed yield. Among nutrient management practices, application of 9 t FYM/ha + GM + Jeevamrit recorded the maximum seed yield of chia. Hence the two treatment combinations excelled over others.

Both weed and nutrient management practices influenced economic indices, viz. net return and return per rupee investment significantly (Table 3). Among weed management practices, hoeing and weeding twice recorded

Table 3. Effect of weed and nutrient management on economics indices of organic chia

Weed management	Nutrient management					
	N_1	N_2	N_3	N_4	N_5	Mean
Net return (×10³ ₹/ha)						
W_1, NLAE 10%	125.79	24.97	68.24	50.62	102.53	74.43
W_2, CLAE 10%	75.84	6.07	46.64	50.62	95.78	54.99
W_3, NLAE 5% + CLAE 5%	62.34	19.57	74.99	69.52	119.95	69.27
W_4, NLAE 5% + CLAE 5% + MW	61.54	18.77	74.20	68.72	136.53	71.95
W_5, Hoeing and weeding twice	113.21	13.75	71.87	73.15	134.81	81.36
W_6, Weedy check	70.35	33.58	34.40	10.03	70.04	43.68
Mean	83.30	17.92	60.19	52.24	108.40	64.41
SEm±			W=3.77, N=1.17, WN=4.56, NW=2.86			
CD (P=0.05)			W=11.89, N=3.32, WN=13.93, NW=8.13			
Return/rupee investment						
W_1, NLAE 10%	2.70	1.47	2.22	1.73	2.35	2.09
W_2, CLAE 10%	2.02	1.11	1.83	1.73	2.27	1.79
W_3, NLAE 5% + CLAE 5%	1.84	1.37	2.34	2.00	2.45	2.00
W_4, NLAE 5% + CLAE 5% + MW	1.79	1.33	2.24	1.94	2.72	2.00
W_5, Hoeing and weeding twice	2.37	1.22	2.11	1.94	2.60	2.05
W_6, Weedy check	2.07	1.74	1.72	1.16	2.04	1.75
Mean	2.13	1.37	2.08	1.75	2.41	1.95
SEm±			W=0.06, N=0.02, WN=0.07, NW=0.04			
CD (P=0.05)			W=0.19, N=0.05, WN=0.22, NW=0.12			

NB, Price of chia seed ₹300/kg; W, Weed management; N, Nutrient management; WN, W at same or different level of N; NW, N at same level of W.

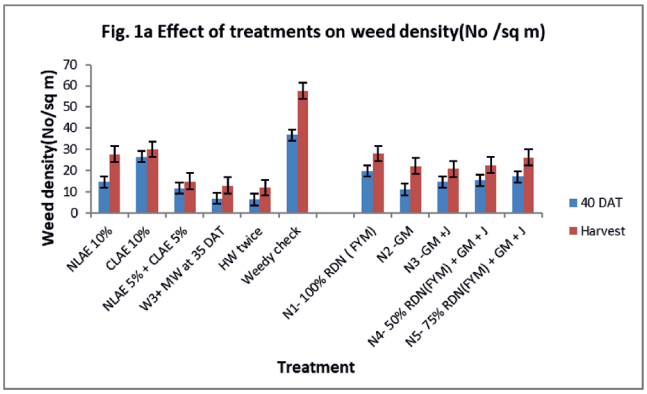

Fig. 1a. Effect of nutrient and weed management on weed density (at 40 DAT and harvest) of winter transplanted organic chia

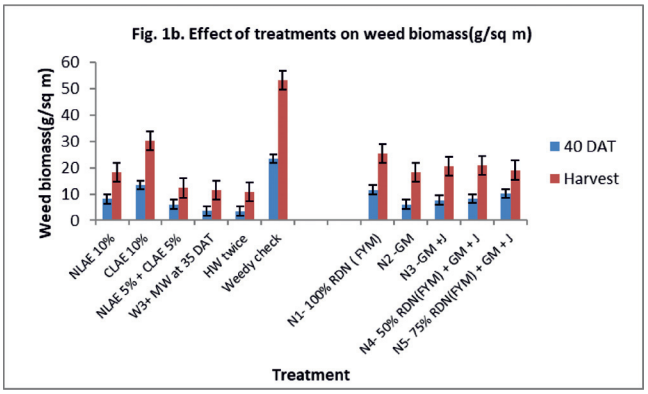

Fig. 1b. Effect of nutrient and weed management on weed biomass (at 40 DAT and harvest) of winter transplanted organic chia

the maximum net return of ₹81.36 × 10³/ha and application of NLAE 10% and NLAE 5% + CLAE 5% + manual weeding recorded statistically similar net return/ha. Among nutrient management practices, application of FYM 9 t/ha + GM + Jeevamrit gave the maximum net return of ₹108.40 × 10³/ha. All other nutrient management practices gave significantly less net return/ha. Among treatment combinations, weed management by NLAE 5% + CLAE 5% + manual weeding with application of FYM 9 t/ha + GM + Jeevamrit gave the maximum net return of ₹136.53 × 10³/ha. The same nutrient management with hoeing and weeding twice gave net return of ₹134.81 × 10³/ha and remained statistically at par. All other treatment combinations gave significantly less net return/ha. The two hoeing weeding with application of 9 t/ha + GM + Jeevamrit gave the maximum seed yield and gross return, but comparatively lower cost of cultivation under NLAE 5% + CLAE 5% + manual weeding caused this differences for net return. Among weed management practices, NLAE 10% gave the maximum return/rupee investment of 2.09. Except CLAE 10% and weedy check recorded statistically similar return/rupee investment. Among nutrient management practices, application of FYM 9 t/ha + GM + Jeevamrit recorded the maximum value of 2.41. Among treatment combinations, weed management by NLAE 5% + CLAE 5% + manual weeding with FYM 9 t/ha + GM + Jeevamrit gave the

maximum return/rupee investment of 2.72. The same nutrient management practices under hoeing and weeding twice gave statistically similar return/rupee investment.

It may be concluded that weed management by *Nerium oleander* leaf aqueous extract 5% + castor leaf aqueous extract 5% + manual weeding at 35 days after transplanting or hoeing and weeding at 20 and 35 days after transplanting along with application of FYM @9 t/ha + green manuring of sunn hemp + jeevamrit recorded the maximum yield of seed, oil and protein, and gave the maximum net return, besides offering satisfactory weed management.

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