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Feasibility of companion cropping of sunflower (*Helianthus annuus*) and ashwagandha (*Withania somnifera* Dunal) with various rows ratio and seed rates under rainfed condition

H.T. CHANDRANATH* AND B.T. PUJARI[1]

Agriculture Technology Information Centre and Extension Education Unit, University of Agricultural Sciences, DHARWAD (KARNATA) INDIA (Email: htcnath@rediffmail.com)

ABSTRACT

A field experiment was conducted during late *Kharif* seasons of 2004 and 2005 to know the feasibility of integration of mediculture with sunflower(*Helianthus annuus*)to achieve the sustainability. The intercropping system of sunflower with ashwagandha (*Withania somnifera*) was found beneficial over sole cropping of sunflower. Among the rows ratio, either 1:6 or 1:7 of sunflower + ashwagandha was most productive and remunerative, as they recorded the maximum sunflower equivalent yield (2.76 t / ha and 2.78 t /ha, respectively), net returns (Rs.31.70 x 10^3 / ha) and other competition functions. Among the seed rate levels, use of 100 % seed rate of ashwagandha was found economical.

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Key words : Ashwagandha, Companion crops, Economics, Row ratio, Seed rate and sunflower

INTRODUCTION

Sunflower (*Helianthus annuus*) is an important oilseed crops Karnataka. In the recent years, because of the occurrence viral disease and other factors, the production is being affected. Intercropping is one of the well known systems for reducing the risk. Off late, cultivation of medicinal crops is gaining importance because of its higher returns with less input. Hence, cultivation of medicinal crop as a component crop in companion cropping system not only increases harvest per unit land, increases generation of employment but also reduces the risk of agriculture crops. Ashwagandha (*Withania somnifera* Dunal) a long duration medicinal crop differs morphologically and physiologically in growth habits with sunflower is thought off to grow as a component crop in sunflower + ashwagandha system. Research work on this aspect is lacking. Hence, the present investigation was undertaken to know the feasibility of growing ashwagandh with sunflower.

MATERIALS AND METHODS

Field experiments were conducted at Regional Agricultural Research Station, Raichur (latitude 16^0 15^1 N and longitude of 77^0 20^1 E), Karnataka during late *Kharif* seasons of 2004 and 2005 on medium black soil under rainfed condition. The soil of the experimental field was low in available nitrogen (231 kg/ha) medium in available in phosphorus (24.8 kg/ha) and high in available potassium (394 kg/ha) with pH 8.3. The bulk density of the soil was 1.34 with field capacity of 36% and permanent wilting point of 12%. The moisture content at the time of sowing was 30%. There were twelve treatments (T_1 : Sole sunflower (SF) (60 cm x 30 cm); T_2 : Sole Ashwagandha (AG) (15 cm x 15 cm); T_3 : SF (60 x 30 cm) + AG (1:3): 100% recommended seed rate of AG (RSAG); T_4 : SF (60 x 30 cm) + AG (1:3): 50% RSAG; T_5 : SF (75 x 24 cm) + AG (1:4): 100% RSAG; T_6 : SF (75 x 24 cm) + AG (1:4): 50% RSAG; T_7 : SF (90 x 20 cm) + AG (1:5): 100% RSAG; T_8 : SF (90 x 20 cm) + AG (1:5): 50% RSAG; T_9 : SF (105 x 17 cm) + AG (1:6): 100% RSAG; T_{10} : SF (105 x 17 cm) + AG (1:6): 50% RSAG; T_{11} : SF (120 x 15 cm) + AG (1:7): 100% RSAG; T_{12} : SF (120 x 15 cm) + AG (1:7): 50% RSAG were tested in a Randomized Block Design with three replications. Sunflower (sole) was supplied with 35-50-35 kg N- P- K/ha at the time of sowing. For sole ashwagandha 12-24 kg N-P /ha was applied at sowing. No additional nutrients were given to the ashwagandha. The sunflower hybrid KBSH-1 and Jawahar asgandh-20 of ashwagandha cultivar were used in the experiment. The crops were sown on 9 September 2004 and on 27

*** Author for correspondence.** (Present Address):
Department of Plant Breeding, Agricultural Research Station, Junagadh Agricultural University, AMRELI (GUJARAT) INDIA

August 2005. A total rainfall of 722mm and 935.6mm was received during 2004 and 2005, respectively as against average rainfall of 719.2mm. The sunflower crop was harvested on 29 December 2004 and 14 December 2005. The ashwagandha crop was harvested on 20 February 2004 and 10 February 2005. Crop competition indices such as land equivalent ratio (LER) and area time equivalent ratio (ATER) were worked out as suggested by Willey (1979) and Hiebsch (1980), respectively.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of Intercropping:

Sunflower:

The mean data of two years revealed that, the seed yields of sunflower did not differ significantly when grown as a sole crop (1.33 t/ha) and as an intercrop (1.22 t/ha) (Table 1). The yield attributes like head diameter, test weight and seed filling % also realized similar trend. The extent of reduction in seed yield under intercropping system was nine per cent when compared to sole crop yield. Though non significant, reduced seed yield of sunflower under intercropping system might be attributed to increased plant population/ unit area resulting in increased competition for growth resources, especially for moisture and nutrient. As sunflower is very fast growing and having early vigour, gained advantage over its intercrop with respect to growth and development of the crop resulting in non significant difference of yield reduction. Intercrop ashwagandha which has a slow initial growth did not pose competition to sunflower at any stage of its growth and consequently resulting in near normal growth and development of sunflower. Similar results of decreased sunflower yields were reported in groundnut + sunflower (Sahoo *et al.,* 2003) or groundnut + pigeonpea system (Agasimani *et al.,* 2001).

Ashwagandha:

The dry root yield (745 kg/ha) of sole ashwagandha was found to be significantly higher than that recorded in intercropping system *i.e.*,551 kg/ha (Table 1), there a 35 % reduction in ashwagandha root yield was observed under intercropping system. The ashwagandha root yield influencing parameters like root length, fresh and dry root weight also followed the similar trend. This could be attributed mainly to reduced population as compared to sole crop population, besides, the total population of ashwagandha and sunflower per unit area was higher resulting in increased competition for growth resources,

Table 1 : Sunflower seed yield and yield parameters as influenced by row proportions and seed rates of ashwagandha in companion cropping of sunflower and ashwagandha

Treatments	Hundred seed weight (g)			Seed filling percentage			Head dia (cm)			Sunflower seed yield (t/ ha)		
	2004	2005	Mean	2004	2004	2004	2004	2005	Mean	2004	2005	Mean
Cropping system												
Sole sunflower	5.10	4.90	5.00	78.0	77.0	77.5	13.4	14.0	13.70	1.40	1.27	1.33
Intercropped sunflower	4.70	4.70	4.70	70.0	71.0	70.5	12.8	13.1	12.95	1.29	1.16	1.22
CD (P = 0.05)	NS	NS		NS	NS		NS	NS		--	--	--
Row proportions (R)												
1:3	4.15	3.95	4.05	63.6	66.0	64.8	12.8	13.2	13.00	1.20	1.07	1.13
1:4	4.60	4.15	4.38	66.5	68.0	67.2	13.3	13.6	13.45	1.24	1.13	1.18
1:5	4.90	4.65	4.78	73.0	72.0	72.5	12.4	12.5	12.45	1.33	1.20	1.26
1:6	5.00	4.65	4.82	74.5	75.0	74.8	12.9	13.1	13.00	1.34	1.21	1.27
1:7	4.90	4.65	4.78	73.0	73.0	73.9	12.8	12.9	12.85	1.32	1.19	1.25
CD (P = 0.05)	0.45	0.42		6.00	5.90		NS	NS		0.096	0.089	0.092
Seed rates of ashwagandha (S)												
50p cent	4.82	4.80	4.81	72.0	71.8	71.9	13.0	13.3	13.15	1.27	1.14	1.23
100 per cent	4.60	4.50	4.55	68.0	70.0	69.0	12.7	12.8	12.75	1.30	1.18	1.24
C.D. (P = 0.05)	NS	NS		NS	NS		NS	NS		NS	NS	NS
Interaction R x S												
C.D. (P = 0.05)	NS	NS		NS	NS		NS	NS		NS	NS	NS

NS=Non-significant

specially the moisture, nutrients and light. Muniram and Kumar (1998) also observed reduction in geranium yield when intercropped with garlic/ onion/ chilli.

Effect of row proportions:

Sunflower :

It was found that, the contrasting growth habits specially with respect to duration of ashwagandha would make it ideal for component cropping for higher productivity with least competition. The seed yield of sunflower under 1:5, 1:6 and 1:7 row proportions of sunflower and ashwagandha were at par with each other and were significantly superior over 1:3 row proportion. The seed yield produced under 1:5, 1:6 and 1:7 were higher by 11, 13 and 11 %, respectively when compared to the seed yield recorded under 1:3 (sunflower: ashwagandha) row proportions. The higher seed yield of sunflower recorded under 1:5, 1:6 and 1:7 row proportions could be due to their higher yield attributing characters *viz.,* test weight and seed filling % (Table 2).

Ashwagandha:

It was observed that dry root yield of ashwagandha under 1:3 row proportion recorded significantly lower yield compared to other row proportions studied. Among other row proportions, the dry root yield obtained under 1:5, 1:6 and 1:7 were at par with each other and significantly higher when compared to 1.4 row proportion. The dry root yield produced under 1:5, 1:6 and 1:7 were higher by 22, 25 and 29 %, respectively when compared to the dry root yield recorded under 1:3 (sunflower: ashwagandha) row proportions. The reductions in dry root yield might be attributed to the competition for light or moisture under 1:3 and 1:4 row proportions (Table 2).

Effect of seed rates:

Sunflower:

Intercropping of sunflower at two seed rates of ashwagandha (50 and 100% of sole crop) revealed that, the seed yield of sunflower with 100 % seed rate of ashwagandha (1.24 t/ha) was on par with sunflower yield obtained by 50 % seed rate of ashwagandha (1.2 t/ha). The increase was to an extent of around four per cent. This indicated that, there was least competition from the intercrop (ashwagandha) irrespective of seed rate. At par seed yield of sunflower obtained at both seed rate levels could be due to similar performance of yield attributing characters like test weight and seed filling percentage. This may be due to same trend of dry matter production at different stages of growth and its accumulation in

Table 2 : Dry root yield and yield parameters of ashwagandha as influenced by row proportions and seed rates of ashwagandha in companion cropping of sunflower and ashwagandha

Treatments	Root length (cm)			Fresh root weight (g)			Dry root weight (g)			Dry root yield of ashwagandha (kg/ha)			Seed yield of ashwagandha (kg/ha)		
	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean
Cropping system															
Sole ashwagandha	30.90	34.53	32.71	22.96	24.10	23.53	5.14	5.58	5.36	701	788	745	303	379	341
Intercropped ashwagandha	23.10	26.49	24.79	17.11	17.97	17.54	3.83	4.17	4.00	520	587	551	241	282	262
C.D. (P = 0.05)	2.81	3.60		2.10	2.11		0.46	0.46		0.08	0.07	0.05	29.5	32.3	31.0
Row proportions (R)															
1:3	19.73	22.46	21.11	14.60	15.25	14.93	3.28	3.53	3.41	447	498	473	207	240	224
1:4	21.68	24.78	23.21	16.08	16.80	16.44	3.60	3.89	3.74	491	549	520	227	264	246
1:5	24.26	27.73	26.00	17.98	18.81	18.39	4.04	4.37	4.20	534	615	575	254	296	275
1:6	24.36	28.56	26.48	18.08	19.38	18.73	4.05	4.49	4.21	552	633	593	255	304	280
1:7	25.36	28.95	27.15	18.76	19.63	19.20	4.21	4.55	4.38	575	642	608	265	308	287
C.D. (P = 0.05)	1.80	2.17		1.37	1.32		0.30	0.31		0.05	0.04	0.03	19.0	21.0	20.1
Seed rates of ashwagandha (S)															
50 Per cent	22.05	25.48	23.78	17.87	18.66	18.26	4.01	4.33	4.17	493	565	529	231	271	251
100 Per cent	24.11	27.51	25.81	16.33	17.28	16.81	3.66	4.01	3.84	547	610	578	252	293	273
C.D. (P = 0.05)	1.16	1.37		0.86	0.84		0.19	0.19		0.03	0.02	0.02	12.0	13.3	12.7
Interaction R x S															
C.D. (P = 0.05)	NS	NS		NS	NS		NS	NS		NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 3 : Land equivalent ratio, area time equivalent ratio (ATER), sunflower equivalent yield, net returns, B: C and cost of cultivation as influenced by row proportions and seed rates of ashwagandha in companion cropping of sunflower and ashwagandha

Treatments	LER			ATER			Sunflower equivalent yield (t/ha)			Net returns (Rs/ha)			B : C			Cost of Cultivation ($\times 10^3$ Rs/ha)		
	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean	2004	2005	Mean
Cropping system																		
Sole sunflower	1.00	1.00	1.00	1.00	1.00	1.00	1.40	1.27	1.33	12.75	10.68	11.72	1.32	1.11	1.22	9.62	9.58	9.60
Intercropped sunflower	1.67	1.67	1.67	1.32	1.32	1.32	2.56	2.67	2.60	28.11	28.87	28.49	2.22	2.24	2.23	12.46	12.42	12.44
C.D. (P=0.05)	0.16	0.16		0.13	0.12		4.12	0.25		4.18	4.88							
Row proportions (R)																		
1:3	1.50	1.48	1.19	1.18	1.16	1.17	2.16	2.31	2.32	24.46	24.27	24.37	1.93	1.90	1.92	12.61	12.74	12.67
1:4	1.60	1.60	1.60	1.26	1.26	1.26	2.47	2.50	2.49	23.79	27.22	25.50	1.89	2.13	2.01	12.53	12.65	12.68
1:5	1.73	1.74	1.74	1.37	1.39	1.36	2.71	2.74	2.66	29.99	31.03	30.51	2.37	2.43	2.40	12.67	12.80	12.73
1:6	1.76	1.77	1.79	1.40	1.41	1.39	2.73	2.79	2.76	30.85	32.00	27.78	2.43	2.50	2.47	12.67	12.26	12.47
1:7	1.78	1.76	1.77	1.42	1.41	1.42	2.76	2.79	2.78	31.49	31.90	31.70	2.48	2.49	2.49	12.67	12.39	12.53
CD (P=0.05)	0.09	0.10		0.07	0.07		0.27	0.17		2.72	2.66							
Seed rates of ashwagandha (S)																		
50 Per cent	1.63	1.62	1.63	1.28	1.29	1.28	2.52	2.55	2.52	27.41	28.02	27.71	2.16	2.19	2.18	12.60	12.73	12.66
100 Per cent	1.73	1.73	1.73	1.37	1.36	1.37	2.61	2.70	2.68	28.80	30.35	29.58	2.25	2.34	2.31	12.70	12.82	12.76
C.D. (P=0.05)	0.06	0.06		0.05	0.04		NS	0.11		0.17	0.16							
Interaction R x S																		
C.D. (P=0.05)	NS	NS		NS	NS		NS	NS		NS	NS	NS	NS	NS				

Note: Average Market price — Sunflower (Rs/q) 1600; Ashwagandha (Rs/q) 4000 (dry root); Rs.50 / kg (seeds)

capitulum. This in turn might be attributed to lower competition posed by ashwagandha for the growth resources especially nutrients and moisture.

Ashwagandha:

The sunflower intercropped with 100 % seed rate of ashwagandha recorded significantly higher dry root yield (578 kg/ ha) than with 50 per cent seed rate of ashwagandha (529 kg/ha). The dry root yield of ashwagandha at their higher seed rate was significantly higher by 9 % as compared to the root yield with lower seed rate level (Table 2).

Sunflower equivalent yield (kg/ ha):

The intercropping of sunflower with ashwagandha at different row proportion and seed rates influenced the sunflower equivalent yield (SEY) significantly. The intercropped sunflower recorded a SEYs 2.60 t/ha and was reduced by 96 % (1.33 t/ha) in the sole crop of sunflower. This was attributed to better performance and yield of component crops.

The sunflower equivalent yield of 2.76 t/ha and 2.78 t/ha under 1:6 and 1:7 row proportions, respectively were significantly higher when compared to other row proportions and were 18 and 19 % higher, respectively over 1:3 row proportion. This may be attributed to the better space available to intercrop for their normal growth besides providing sufficient space to ashwagandha after the harvest of sunflower.

The sunflower intercropped with 100 % seed rate of intercrop (ashwagandha) recorded significantly higher SEY (2.68 t/ ha) than the sunflower equivalent obtained when sunflower was intercropped with 50 % seed rate of intercrop (2.52 t/ha). The reduction in sunflower equivalent at lower (50%) seed rate was to an extent of 6 % per cent over higher 100% seed rate. This was mainly attributed to higher root yields of ashwagandha.

Land equivalent ratio (LER) and area time equivalent ratio (ATER):

Intercropped sunflower realized

maximum LER (1.67) and ATER (1.32) over sole sunflower (Table 3). Such higher LER and ATER indicate the efficient use of land and time. The component crop (ashwagandha) differed in its use of growth resources and utilized them more efficiently resulting in higher yields per unit area per unit time than that produced by sole crop. Among row proportions, 1:7 recorded maximum LER (1.77) and ATER (1.42) which was 77 and 42 % highr compared to sole sunflower. Among seed rates, 100% seed rate of ashwagandha recorded significantly higher LER (1.73) and ATER (1.37) over sole sunflower. Muniram and Kumar (1998) and Maheswari *et al.* (1997) reported such higher LER when medicinal and aromatic crops were intercropped with garlic, onion or chilli. Singh *et al.* (2001) reported a yield advantages on ATER basis in citronella + cowpea or citronella + soybean system.

Economics of the system**:**

The intercropped sunflower recorded higher net income (Rs. 28,492/ha) and B:C (2.23) as compared to sole sunflower. This higher net return was due to the maximum sunflower equivalent obtained under intercropping system (Table 3). Similar reports were obtained by Singh *et al.* (1998) when mint was intercropped with radish and Pareek and Maheswari (1993) when vetiver was intercropped with pulse crops. Among various row proportions studied, significantly higher net returns (Rs.31.70 x 10^3 /ha) and B:C (2.49) were obtained under 1:7 row proportion compared to other row ratios except 1:6 row proportion. Among seed rate levels, 100 % seed rate of ashwagandha recorded net return (Rs. 29.58 x 10^3/ha). Interaction effects were found non significant.

Intercropping of sunflower with medicinal crop like ashwagandha under 1:6 or 1:7 ratio with 100 % seed rate of ashwagandha is more sustainable , as these associations are accounted for better values in respect of biological parameters and are economically more productive.

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