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Allelopathic effect of summer sunflower on mungbean under varied sowing dates

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Abstract
Field experiment was conducted during *kharif* season of 2014 and 2015 at Main Agricultural Research Station, UAS, Dharwad to know the allelopathic effect of preceded summer sunflower on *kharif* mungbean (*Vigna radiata*) under varied sowing dates. Pooled data indicated that significantly higher seed yield of mungbean was obtained in *kharif* mungbean preceded by summer fallow land (CS_2-556 kg ha^{-1}) compared to *kharif* mungbean preceded by summer sunflower (CS_1-397 kg ha^{-1}). All the growth and yield parameters of mungbean were affected when it was preceded by summer sunflower which indicated the allelopathic effect of sunflower on mungbean.

Keywords: Allelopathy, sunflower, mungbean, sowing dates

Introduction
Allelopathy plays an important role in the agroecosystems leading to a wide array of interactions between crop-crop, crop-weed and tree-crops. Generally, these interactions are harmful to the receiver plants but provide a selective benefit to the donor. Sunflower (*Helianthus annus* L.) being thermo and photo-insensitive, it can be grown round the year in sub-tropics and fits well in the multiple cropping systems. In Karnataka, sunflower grown in an area of 4.30 lakh hectare and is mainly grown in Northern Karnataka in medium to deep black soils and it comprises the districts of Bagalkot, Belgaum, Bijapur, Dharwad, Gadag, Gulbarga, Koppal, Raichur and Yadgir. In some pockets of these districts sunflower is grown in summer also. In sunflower species several substances with allelopathic properties such as phenolic compounds, diterpenes and triterpenes have been isolated and chemically characterized (Macias *et al*., 1993) [2]. Crop residues of sunflower also produce harmful effects on the germination and growth of subsequent crops (Macias *et al*., 1999) [1].
Mungbean (*Vigna radiata* L. Wilczek) is one of the important pulse crops of Karnataka with an area of 3.69 lakh ha. It is observed that there is reduction in the yield of *kharif* mungbean by the residual effect of summer sown sunflower. To address the issue of residual effect of summer sunflower on *kharif* mungbean crop, to know the per cent yield reduction in *kharif* mungbean by the residual/allelopathic effect of summer sunflower and optimization of interval between sowing of mungbean and harvesting of sunflower to have minimum allelopathic effect, this study was conducted.

Material and Methods
A field experiment was conducted during *kharif*- 2014 and 2015 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karnataka) which situated at 15°26' N latitude, 75°01' E longitude and at an altitude of 678 m above mean sea level. The soil of experimental site was medium black clay soil, with low nitrogen (253.4 kg ha^{-1}), medium phosphorous (27.7 kg ha^{-1}) and high potash (325.84 kg ha^{-1}). Experiment was laid out in a split plot design replicated thrice with different cropping system in main plots and sowing dates in sub plots. Two cropping systems (CS_1-*kharif* mungbean preceded by summer sunflower and CS_2-*kharif* mungbean preceded by summer fallow) were used in the study and sowing was done as per sowing date treatments [D_1-28th June (three weeks after harvest of sunflower), D_2-5th July (four weeks after harvest of sunflower), D_3-12th July (five weeks after harvest of sunflower) and D_4-19th July (six weeks after harvest of sunflower)]

Results and Discussion
Effect of summer sunflower on growth and yield of mungbean
Based on pooled analysis, *kharif* mungbean preceded by summer fallow land recorded significantly higher seed yield (556 kg ha^{-1}) than *kharif* mungbean preceded by summer sunflower (397 kg ha^{-1}). The increase in seed yield of CS_2 over CS_1 was to an extent of 28.60

per cent. This increase was due to increase in the growth and yield parameters of mungbean in CS_2 which was resulted in significantly higher number of pods (11.84) than CS_1 (9.20). The increase in number of pods per plant of CS_2 over CS_1 was to an extent of 22.30 per cent (Table 2). The yield parameters were directly correlated with the growth parameters.

Kharif mungbean preceded by summer fallow land (CS_2) recorded significantly higher plant height (51.36 cm) and number of branches per plant (8.26) as compared to *kharif* mungbean preceded by summer sunflower (39.59 and 7.91, respectively) (Table 2). This was mainly due to allelochemicals which suppressed the photosynthetic absorption of carbon dioxide, and was resulted into stunted growth of mungbean. The phytotoxicity of sunflower biomass persisted in soil upto four to five weeks after soil incorporation. These results indicated that sunflower plants released and accumulated the phytotoxins in the soil which adversely affected the succeeding test crop. These results are corroborating with the results of Narval *et al*., 1999 [3].

Effect of sowing dates on growth and yield of mungbean

Among sowing dates, mungbean crop sown after three weeks of harvest of sunflower (28th June) recorded significantly higher seed yield (819 kg ha^{-1}) when compared to crop sown after four, five and six weeks of harvest of sunflower (D_2-491 kg ha^{-1}, D_3-335 kg ha^{-1} and D_4-260 kg ha^{-1}, respectively). The crop sown after three weeks after harvest of sunflower registered 40.05, 59.10 and 68.25 per cent higher seed yield over four, five and six weeks after harvest of sunflower, respectively. The higher seed yield obtained in early sown crop is attributed to higher soil moisture during cropping period. This coincides with the flowering and pod formation stage of early sown crop (Table 2).

Even though the impact of allelopathic effect of sunflower was higher in early days *viz.*, immediately after the harvest of sunflower compared to later days, the higher yield in D1 (three weeks after harvesting of sunflower) compared to D2,D3 and D4 was due to the non suitability of weather conditions prevailed during five and six weeks after harvesting of sunflower. It might be because of higher infestation of pests and disease in later stages of crop and deficit of soil moisture might have coincided with flowering stage resulted in lower seed yield of mungbean in delayed sowing dates (D3 and D4) treatments.

The value of growth parameters like plant height and number of branches per plant were also significantly higher in early sown crop which were responsible for higher total dry matter per plant and increased value of yield components ultimately resulting in increased seed yield per ha.

The plant height and number of branches per plant at harvest in early sown crop (June 28th) were 47.95 cm and 8.56, respectively (Table 1) which were significantly higher than crop sown at D3 (12th July) and D4 (19th July) after five and six weeks after harvest of sunflower and was on par with crop sown at D2 (5th July), after four weeks after harvest of sunflower (47.30 cm and 8.20, respectively).

Interaction effect of cropping system and sowing dates on growth and yield of mungbean

In the present investigation, based on pooled data, the interaction effect of *kharif* mungbean preceded by summer fallow at the date of D_1 (CS_2D_1) was noticed significantly higher seed yield (971 kg ha^{-1}) as compared to otherinteractions. However, the lowest seed yield was recorded in *kharif* mungbean sown after six weeks of harvest of summer sunflower (CS_1D_4-207 kg ha^{-1}) as compared to other treatment combinations. The increase in yield might be due to better manifestation of growth and yield attributing characters like plant height (57.16 cm), number of branches per plant (8.90) and number of pods per plant (13.84) which contributed to the higher seed yield (Table 2).

The interaction effects of *kharif* mungbean sown after three weeks of harvest of summer sunflower recorded significantly higher seed yield (CS_1D_1-667 kg ha^{-1}) as compared to other treatment combinations of summer sunflower. This was mainly due to allelochemical produced by the sunflower plant residues were reduced by biodegradation (Waller and Dermer, 1980) [4].

As there was delay in the sowing period in the *kharif* mungbean preceded by summer sunflower (CS_1) the impact of allelopathy decreases exponentially and at later period of sowing, there was no significant difference in the yield of mungbean in treatment combinations such as *kharif* mungbean sown after five and six weeks of harvest of summer sunflower (CS_1D_3 and CS_1D_4, respectively). But in our study, mungbean crop sown after three weeks of harvest of sunflower (28th June) recorded significantly higher seed yield than other delayed sowing dates in both cropping system.

The performance of crop in different cropping system was exceptionally well in terms of plant vegetative growth and pod setting when the crop was sown after three weeks of harvest of sunflower (D_1) as compared to other sowing dates. There was significant difference between the cropping systems in respect of grain yield in sowing dates of D1 and D2, where CS1D1 and CS1D2 recorded significantly lower yield (667 and 422kg/ha, respectively) than CS1D2 and CS2D2 (971 and 561kg/ha, respectively), where the allelopathic effect was nullified and both the systems were on par with each other in CS1D3 and CS2D3 and the similar effect in CS1D4 and CS2D4.

Table 1: Growth of mungbean as influenced by different cropping systems and sowing dates

Treatment	Plant height (cm)									No. of branches per plant								
	2014			2015			Pooled			2014			2015			Pooled		
	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean
D_1	56.48	62.99	59.74	21.00	51.33	36.17	38.74	57.16	47.95	8.54	9.03	8.79	7.90	8.77	8.34	8.22	8.90	8.56
D_2	49.99	55.96	52.98	27.33	55.90	41.62	38.66	55.93	47.30	8.16	8.82	8.49	8.23	7.57	7.90	8.20	8.20	8.20
D_3	44.20	46.57	45.39	39.33	42.87	41.10	41.77	44.72	43.24	8.00	8.27	8.14	7.53	7.77	7.65	7.77	8.02	7.89
D_4	42.11	43.61	42.86	36.30	51.63	43.97	39.21	47.62	43.41	7.77	7.83	7.80	7.13	8.00	7.57	7.45	7.92	7.68
Mean	48.20	52.28		30.99	50.43		39.59	51.36		8.12	8.49		7.70	8.03		7.91	8.26	
For comparing of means of	SEm.±		CD at 5%	SEm.±		CD at 5%	SEm.±		CD at 5%	SEm.±		CD at 5%	SEm.±		CD at 5%	SEm.±		CD at 5%
CS	0.13		0.8	0.78		2.34	0.455		1.57	0.02		0.11	0.09		0.27	0.05		0.19
D	1.49		4.4	1.1		3.3	1.295		3.85	0.04		0.13	0.21		0.63	0.13		0.38
CSxD	2.11		6.22	1.56		4.68	1.835		5.45	0.06		0.18	0.30		0.90	0.18		0.54

CS: Different cropping systems (CS)
DAS: Days after sowing
CS $_1$: *Kharif* mungbean preceded by summer sunflower
CS $_2$: *Kharif* mungbean preceded by summer fallow
D_3: Five weeks after harvest of sunflower (12th July)
D: Sowing dates (D)
NS: Non significant
D_1: Three weeks after harvest of sunflower (28th June)
D_2: Four weeks after harvest of sunflower (5th July)
D_4: Six weeks after harvest of sunflower (19th July)

Table 2: Grain yield and No. of pods/plant of mungbean as influenced by different cropping systems and sowing dates

Treatment	No. of pods per plant									Grain yield (kg ha^{-1})								
	2014			2015			Pooled			2014			2015			Pooled		
	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean	CS_1	CS_2	Mean
D_1	11.03	13.84	12.44	10.43	12.23	11.33	10.73	13.04	11.88	660	893	777	673	1049	861	667	971	819
D_2	10.11	11.78	10.95	10.43	11.90	11.17	10.27	11.84	11.06	564	631	598	279	491	385	422	561	491
D_3	9.78	10.26	10.02	6.90	12.13	9.52	8.34	11.20	9.77	380	402	391	207	352	279.5	294	377	335
D_4	9.72	10.15	9.94	5.23	12.43	8.83	7.48	11.29	9.38	302	428	365	111	200	155.5	207	314	260
Mean	10.16	11.51		8.25	12.17		9.20	11.84		477	589		318	523		397	556	
For comparing of means of	SEm.±	CD at 5%		SEm.±	CD at 5%		SEm.±	CD at 5%		SEm.±	CD at 5%		SEm.±	CD at 5%		SEm.±	CD at 5%	
CS	0.13	0.80		0.40	1.20		0.27	1.00		20	60		17	51		19	56	
D	0.17	0.51		0.56	1.68		0.37	1.10		23	69		31	93		27	81	
CSxD	0.25	0.73		0.80	2.40		0.53	1.57		31	95		44	176		38	136	

CS: Different cropping systems (CS)
DAS: Days after sowing
CS $_1$: *Kharif* mungbean preceded by summer sunflower
CS $_2$: *Kharif* mungbean preceded by summer fallow
D_3: Five weeks after harvest of sunflower (12th July)
D_4: Six weeks after harvest of sunflower (19th July)
D: Sowing dates (D)
NS: Non significant
D_1: Three weeks after harvest of sunflower (28th June)
D_2: Four weeks after harvest of sunflower (5th July)

Conclusion

From the investigation, it can be concluded that there must be three to four weeks of interval between harvesting of summer sunflower and sowing of *kharif* mungbean. Sowing of mungbean must be before the end of June as it was indicated by higher yield in D_1 (28th June).

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