Forage Res., **40** (1) : pp. 18-22 (2014) **http://forageresearch.in**

PERFORMANCE OF WINTER CROPS IN *JATROPHA CURCAS* BASED INTERCROPPING SYSTEM IN SEMI-ARID REGION OF HARYANA

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(Received : 22 April 2014; Aceepted : 2 June 2014)

SUMMARY

A field experiment was conducted to identify suitable crops for Jatropha-based intercropping system during winter season of 2005-06 and 2006-07 at Department of Forestry Farm, CCSHAU, Hisar. The production potential of mustard (*Brassica juncea*) cv. RH-30, *Eruca sativa* cv. T-27, chickpea (*Cicer arietinum*) cv. HC-5 and barley (*Hordeum vulgare*) cv. BH-393 was evaluated under 5 x 3 m spacing of Jatropha. Jatropha plantation had significant effect on the growth and yield of test crops during both the years of experimentation. However, the growth, yield and yield attributes of all the test crops were reduced more in second year as compared to first year of experimentation. Two year old Jatropha produced negligible seed yield both during 2005-06 and 2006-07 due to frost injury in 2005-06 and excessive vegetative growth during 2006-07. Therefore, susceptibility of Jatropha to frost, requirement of irrigation for flowering and fruiting and poor seed yield have rendered it unsuitable for north India.

Key words : Winter crops, intercropping, growth, yield, allelopathic effects

India is not self-sufficient in petroleum production and nearly 75 per cent of its requirements are being met through imports. Therefore, there is an urgent need for finding out alternate sources of energy which are renewable, safe and non-polluting. After rigorous study and research, oil extracted from different plant species was tested as fuel which could emerge as a strong bio-fuel with minimum effect on environment. All these characteristics were found in one species, called, Jatropha.

Jatropha curcas L. (family Euphorbhiace) is a multipurpose large shrub or small tree. It grows on well drained soil with good aeration and is well adapted to marginal soils with low nutrient content. It grows as a boundary fence or live hedge and can be used to reclaim eroded areas (Joker and Jepsen, 2003). Its leaves and stems are toxic to animals. So, it is not browsed, but after treatment, the seed or seed cake can be used as an animal feed. Being rich in nitrogen, the seed cake is also an excellent source of plant nutrients (Makkar *et al.*, 2001).

Agroforestry is a modern tool to develop sustainable land use and to increase food, feed and fodder production by growing woody species (trees, shrubs, bamboos, etc.) with agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. Because these species co-exist crucial to determine the success of an agroforestry system. A survey of the available information reveals that most of the agroforestry species have negative allelopathic effects on food and fodder crops. Allelopathy and important ecological phenomenon play a significant role in diverse ecosystems. Allelochemicals are the chemicals involved in interplant interactions process diversity in terms of nature and structure. The phenomenon has been reported and agricultural systems are known to be allelopathic. In agroforestry system, the role of allelopathy is especially important as it may lead to soil sickness and may be a casual factor for declining crop productivity reported by Batish *et al*. (2011).

Keeping in view the importance of Jatropha oil, Jatropha plantation is being promoted by different agencies. It could be intercropped with other crops' plants; however, meagre work has been done in relation to intercropping of food, feed and fodder crops with Jatropha. The present study was, therefore, undertaken to find out the suitable summer crops which could be grown with *Jatropha curcas* in interspaces in semi-arid conditions.

MATERIALS AND METHODS

Field experiment was conducted during winter seasons of 2005-06 and 2006-07 at the Research Farm of Department of Forestry, CCS Haryana Agricultural University, Hisar located at $29^0 10'$N latitude and $75^0 46'$E longitude with an elevation of 215.2 m above the mean sea level. The climate of the experimental site is semi-arid with dry hot summer, cold winter and receives 452 mm average annual rainfall (Figs. 1 and 2). Soil of the experimental field was sandy loam in texture, slightly saline in nature, low in nitrogen, and medium in phosphorus and rich in potassium. The field experiment consisted of *J. curcas* planted in September 2003 at 5 x 3 m spacing intercropped with mustard (*Brassica juncea*) cv. RH-30, *Eruca sativa* cv. T-27, chickpea (*Cicer arietinum*) cv. HC-5 and barley (*Hordeum vulgare*) cv. BH-393. The treatments were replicated four times in randomized block design. In between the inter-spaces of Jatropha plantation, all the test crops were sown in middle of October with spacing of 45 x 30 cm in both the years. The recommended package of practices for the test crops was followed both in control and Jatropha. All growth, yield and yield attributes of test crops were recorded at the time of final harvest and analysed statistically. Plant height and branches/plant of Jatropha were recorded during the month of October and clusters/plant and fruits/plant were recorded in October and December months during both the years. Picking of the mature fruits was done at regular intervals from October to January. The Jatropha plants were cut back in March with the help of saw at 45-60 cm above the ground due to killing of the above parts by severe frost in the first fortnight of January 2006. All the plants sprouted again in the months of April-May.

RESULTS AND DISCUSSION

The results of the present study revealed that Jatropha plantation had significant effect on primary and secondary branches per plant, grain yield and oil content per cent during both the years, whereas seeds per siliqua, test weight during first year of experimentation in mustard (Table 1). In *Eruca sativa*, primary and secondary branches per plant and grain yield were significantly reduced during both the years, whereas test weight and oil content during first year and seeds per siliqua were non-significant during both the years of experiment (Table 2). Branches per plant, pods per plant, grain yield and stover yield significantly reduced during both the years i. e. 2005-06 and 2006-07, however, test weight was found non-significant during both the years of

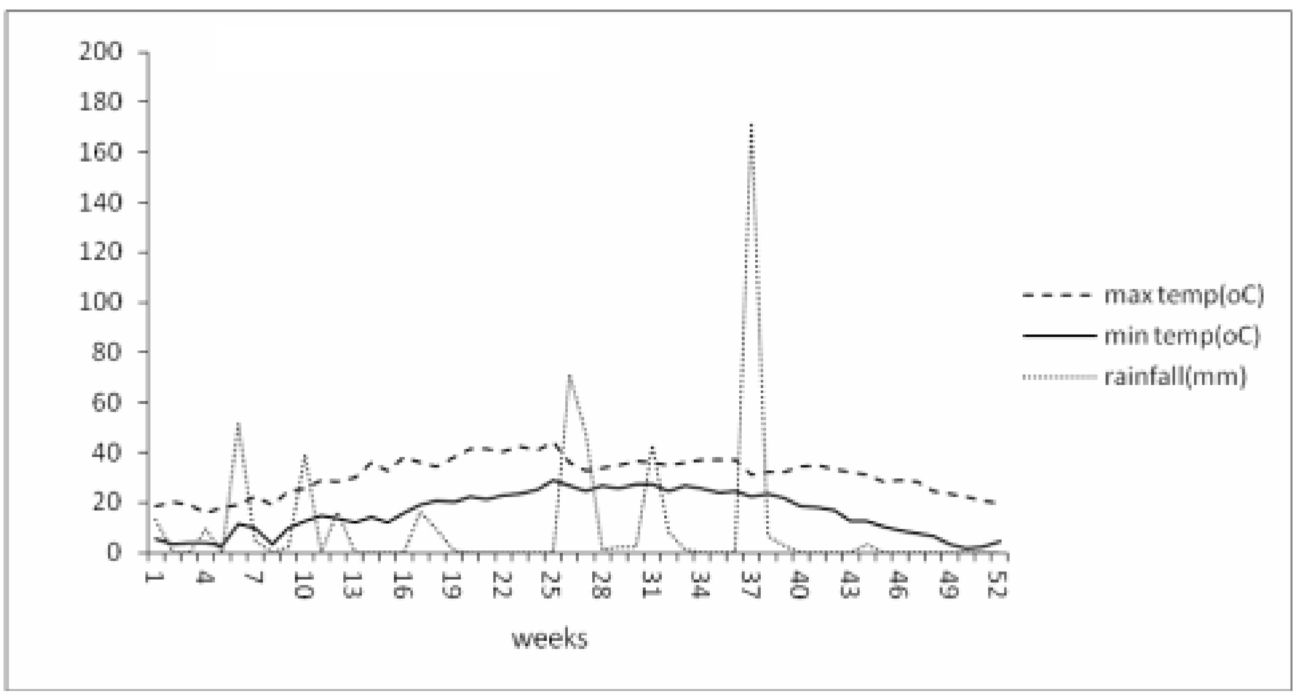

Fig. 1. Weather data during 2005.

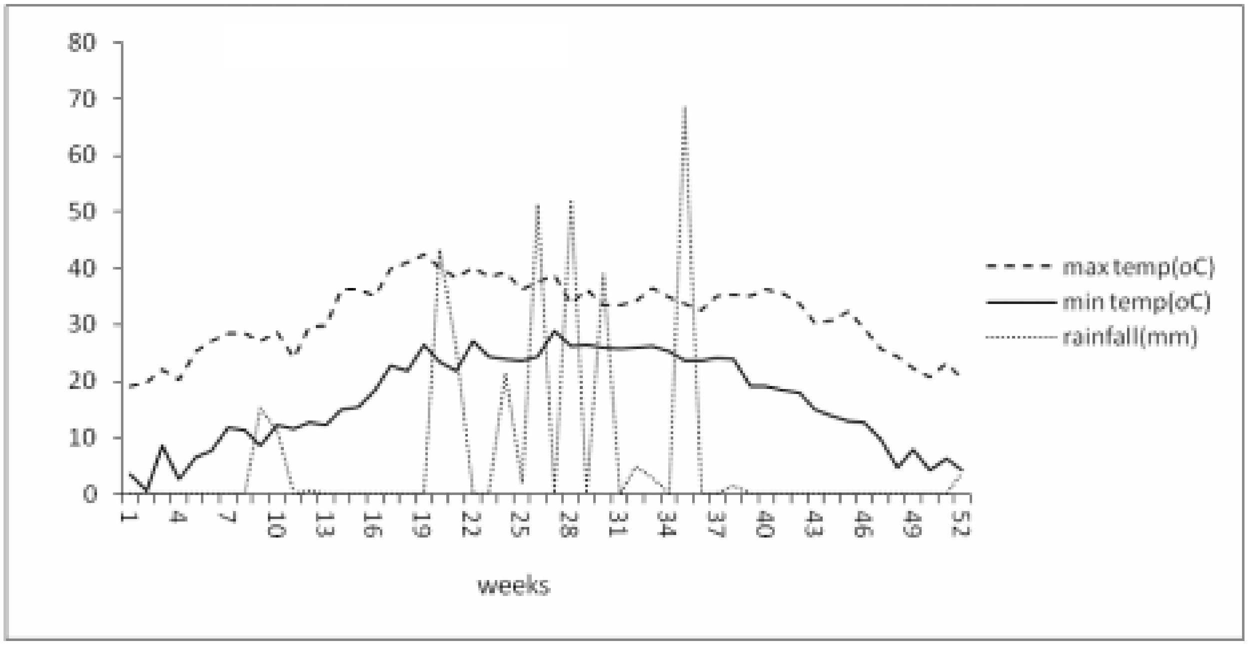

Fig. 2. Weather data during 2006.

TABLE 1
Effect of Jatropha plantation on growth, yield and yield attributes of intercropped mustard

Treatment	Primary branches/ plant		Secondary branches/ plant		Seeds/ siliqua		Test weight (1000 seeds) (g)		Grain yield (q/ha)		Oil content (%)		Harvest index (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Mustard	5.22	5.39	11.33	12.06	11.93	12.26	5.26	5.45	16.75	17.21	48.25	49.36	25.66	25.05
Jatropha+mustard	4.16	3.99	10.26	9.84	11.49	11.32	4.81	4.16	14.75	13.92	46.09	45.38	25.06	25.00
C. D. (P=0.05)	0.26	0.57	0.08	0.50	NS	0.20	NS	0.37	0.42	1.15	0.51	0.16	NS	NS

NS–Not Significant.

TABLE 2
Effect of Jatropha plantation on growth, yield and yield attributes of intercropped *Eruca sativa*

Treatment	Primary branches/ plant		Secondary branches/ plant		Seeds/ siliqua		Test weight (1000 seeds) (g)		Grain yield (q/ha)		Oil content (%)		Harvest index (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Eruca sativa	4.25	4.49	9.68	9.96	20.18	20.30	2.54	2.59	5.56	5.64	36.30	37.55	25.71	25.77
Jatropha+*Eruca sativa*	3.56	3.32	8.44	8.07	19.30	19.17	2.38	2.19	4.96	4.78	35.02	34.98	25.59	25.06
C. D. (P=0.05)	0.24	0.08	0.12	0.03	NS	NS	NS	0.20	0.11	0.12	NS	0.26	NS	NS

NS–Not Significant.

experimentation in chickpea (Table 3). Burman *et al.* (2004) reported that relative yields of chickpea and barley were affected due to Leucaena alleys where in a considerable reduction of 11-12 and 21-23 per cent in chickpea grain and straw yields and 9 and 18-20 per cent in barley grain and straw yields in the mulch and incorporation treatment, respectively. In Table 4, tillers per metre, effective tillers per metre, test weight and stover yield of barley significantly reduced during second year of experimentation, whereas grains per spike and grain yield reduced during both the years. Kanaujia and Bhatia (2000) also reported that grain and stover yield of pearl millet and barley with alley cropping of *L. leucocephala* significantly reduced than control. Sharma (2003) also reported 94 per cent decrease in seed yield of mothbean compared to 71 and 72 per cent seed yield decrease in mungbean and horsebean, respectively, under 7-year old *Acacia tortilis* intercropping system compared to sole cropping. Due to increase in crown size and increased competition of roots for moisture and nutrients, the growth, yield attributes and grain as well as stover yield of all the test crops significantly reduced in association with Jatropha over control during the second year of experimentation. Divya *et al.* (2006) also

TABLE 3
Effect of Jatropha plantation on growth, yield and yield attributes of intercropped chickpea

Treatment	Branches/ plant		Pods/plant		Test weight (1000 seeds) (g)		Grain yield (q/ha)		Stover yield (q/ha)		Harvest (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Chickpea	3.46	3.77	24.29	26.42	129.31	129.58	18.67	19.79	39.76	42.94	32.25	31.75
Jatropha+chickpea	2.90	2.78	21.29	20.09	127.12	126.68	16.39	15.96	35.73	34.95	31.35	31.25
C. D. (P=0.05)	0.25	0.26	0.47	0.33	NS	NS	128	0.56	0.64	1.66	NS	NS

NS–Not Significant.

TABLE 4
Effect of Jatropha plantation on growth, yield and yield attributes of intercropped barley

Treatment	Tillers/m		Effective tillers/m		Grains/ spike		Test weight (1000-seeds) (g)		Grain yield (q/ha)		Stover yield (q/ha)		Harvest index (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Barley	66.76	69.85	58.75	61.53	56.68	57.68	44.91	45.10	31.63	32.26	54.40	56.45	37.04	37.17
Jatropha+barley	66.63	65.53	56.55	54.52	53.32	52.94	43.60	42.96	25.85	27.82	53.97	49.24	36.76	36.36
C. D. (P=0.05)	NS	0.84	NS	0.78	1.22	0.08	NS	0.23	0.86	2.14	NS	2.10	NS	NS

NS–Not Significant.

TABLE 5
Growth, yield attributes and seed yield of Jatropha during 2005-06 and 2006-07

Growth/yield characters	2004-05	2005-06		2006-07	
	Sole Jatropha	Sole Jatropha	Crops+Jatropha	Sole Jatropha	Crops+Jatropha
Plant height (m)	1.9	2.6	2.6	2.5	2.6
Primary branches/plant	7.9	30.6	29.2	36.5	34.2
Clusters/plant	12.2	24.9	20.4	13.8	14.6
Fruits/cluster	9.6	3.7	3.5	24.6	23.4
Seed yield (q/ha)	1.4	0.17	0.15	-	-

reported reduced plant height and grain yield of intercrops i. e. groundnut, blackgram, cowpea, frenchbean, sunflower and gingelly under Jatropha plantation at different spacings. Rizvi *et al*. (1999) found that mimosine inhibited large number of physiological and biochemical parameters in *V. mungo* and *P. aureus*. They found that mimosine inhibited seedling vigour, food mobilization efficiency, solubilization of starch, breakdown of proteins and activity of amylase. The reduced amylase activity was at synthetic as well as catalytic level and it was mediated by gibberellic acid. They further reported that mimosine altered the hormonal balance of the seedlings leading to an inhibition in their growth. When *V. mungo* plants were grown in the soil having different amounts of leucaena leaves, nitrogenise activity of root nodules was inhibited.

Jatropha after two years of plantation (2005-06) produced negligible mean seed yield of 0.16 q/ha with no variation in seed yield between sole crop and intercrop (Table 5). The poor seed yield was due to severe damage to the fruits on account of frost condition (-3.5^{0}C) in the first fortnight of January 2006. Singh *et al.* (2009) also reported susceptibility of Jatropha to frost and its ability to sprout again in spring. The number of fruits/cluster (3.6) was also reduced markedly over the previous (2004-05) year (9.6 fruits/cluster) with negligible variation between intercropped Jatropha and sole Jatropha. It was due to the fact that the Jatropha plants energy was mainly diverted towards vegetative growth which is evident from nearly fourfold increase in branches/plant after pruning in February 2005. Only the fruits which set in early flowering (September) could mature before the frost. During the second year (2006-07) heading back of all the dead branches of Jatropha affected by frost resulted in emergence of a number of new branches resulting in excessive vegetative growth thereby delaying the onset of flowering to the month of October. Whereas under normal conditions, flowering starts by the end of August or early September. Due to delayed flowering, fertilization at low temperature in November and December was poor resulting in very shrivelled kernels with practically negligible oil content. Therefore, seeds were not picked from the plants to avoid wastage of manpower.

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