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STUDIES ON SOIL MOISTURE DEPLETION PATTERN IN *JATROPHA CURCAS* BASED INTERCROPPING SYSTEM

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SUMMARY

In order to find out the depletion of moisture content in Jatropha based intercropping system where **kharif** crops i. e. pearl millet cv. HHB-67, greengram cv. MH-96-1, clusterbean cv. HG-563 and mothbean cv. RMO-40 were sown in 4.5 x 7.5 m size plots at Forestry Farm of CCSHAU, Hisar. Moisture content was studied at the time of sowing, before first and second irrigations at 1 m and 2.5 m distance from Jatropha line planted at 5 x 3 m spacing. Vertical moisture depletion at 0-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80 and 80-90 cm depths was also recorded in Jatropha based intercropping system and in control. The results revealed that depletion of moisture content was higher at 1 m distance as compared to 2.5 m distance due to severe competition of test crops with Jatropha plantation. Maximum moisture depletion pattern was recorded up to 0-50 cm depth in both Jatropha based intercropping system and in control. However, higher moisture depletion was recorded in Jatropha based intercropping system than control. Grain yield of test crops was significantly reduced in Jatropha based intercropping system as compared to control during both the years of study.

Key words : Pearl millet, greengram, clusterbean, mothbean, Jatropha, intercropping

The demand for plant based feedstock for biodiesel production has received much attention in recent years due to green energy policy vis-a vis blending requirements of diesel adopted by many countries (Rajgopal and Zilberman, 2007).

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. 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). Its multifarious benefits as a source of green manure and soil ameliorator improve rural economy by generating huge manpower employment during various stages of its cultivation and downstream processing makes it a potential candidate for large scale plantation on marginal lands (Behera *et al.*, 2010).

Biodiesel like jatropha, karanji, pongamia, simarouba glauca and surahonne oils are available in abundance, which can be converted to biodiesel. The use of vegetable oils, such as palm, soya bean, sunflower, peanut and olive oil as alternative fuels for diesel is being promoted in many countries. All countries are at present heavily dependent on petroleum fuels for transportation and agricultural machinery. The fact that a few nations together produce the bulk of petroleum has led to high price fluctuation and uncertainties in supply for the consuming nations. This in turn has led them to look for alternative fuels that they themselves can produce. Among the alternatives being considered are methanol, ethanol, biogas and vegetable oils. Vegetable oils have certain features that make them attractive as substitute for diesel fuels. Jatropha oil is closely matched with the values of conventional diesel and can be used in the

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existing diesel engine without any modification (Antony *et al.*, 2011; Patil and Arakerimah, 2012; Singh *et al.*, 2013; Maina, 2014; Raghuvanshi and Singh, 2014).

Keeping in view the importance of Jatropha oil, Jatropha plantation is being promoted by different agencies. It could be intercropped with other crop plants; however, meagre work has been done in relation to intercropping of food crops with Jatropha. The present study was, therefore, undertaken to find out the effect of *Jatropha curcas* based intercropping system on crop yield and moisture depletion pattern.

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. 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 *Jatropha curcas* planted in September 2003 at 5 m x 3 m spacing intercropped with greengram (*Vigna radiata*) cv-MH-96-1, clusterbean (*Cyamopsis tetragonoloba*) cv-HG-563, mothbean (*Phaseolus aconitifolius*) cv-RMO-40 and pearl millet (*Pennisetum typhoides*) cv-HHB-67. 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 July 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. Yield of test crops was recorded at the time of final harvest and analyzed statistically. Moisture content was studied at the time of sowing, before first and second irrigations at 1 m and 2.5 m distance from Jatropha line planted at 5 x 3 m spacing. Vertical moisture depletion at 0-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70, 70- 80 and 80-90 cm depths was also recorded in Jatropha based intercropping system and in control. Number of branches per plant, number of flower clusters per plant, number of fruits per cluster, number of seeds per kernel and seed yield (q/ha) of Jatropha were recorded. 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 month of April-May.

RESULTS AND DISCUSSION

The results of the present study revealed that Jatropha plantation had no adverse effect on yield of greengram, clusterbean and pearl millet during the first year of experimentation. However, grain yield of mothbean was significantly reduced even during the first year of experimentation (Fig. 1). It could be ascribed to more sensitivity of mothbean to shade and below ground interferences of Jatropha. 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 seven years 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 grain yield of all the test crops was significantly reduced in association with Jatropha over control during the second year of experimentation. Divya *et al.* (2006) also 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

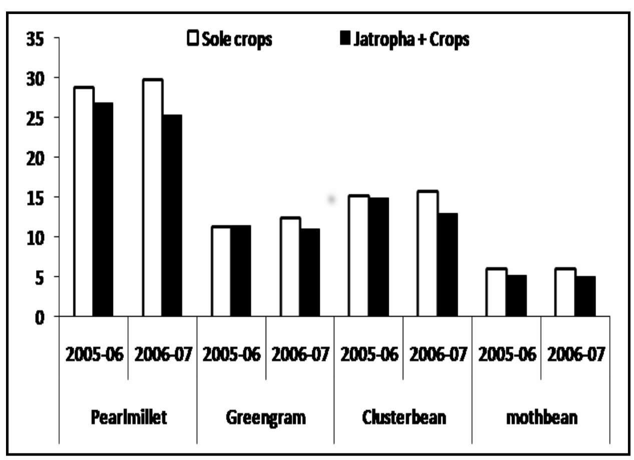

Fig. 1. Effect of *Jatropha curcas* on grain yield (q/ha) of **kharif** crops.

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 (Fig. 2). 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 (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

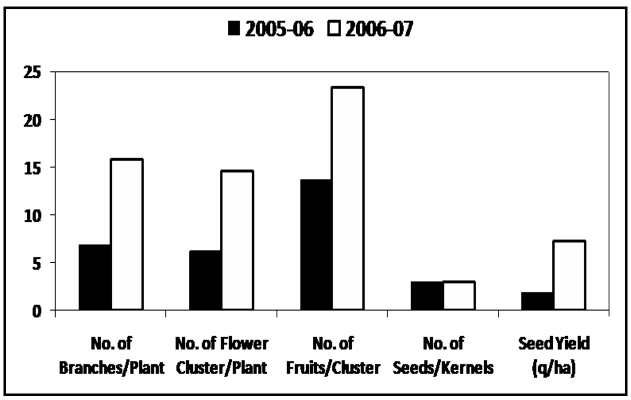

Fig. 2. Growth yield attributes and seed yield of Jatropha during 2005-06 and 2006-07.

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), number of branches per plant, number of flower clusters per plant, number of fruits per cluster, number of seeds per kernel and seed yield (q/ha) were found more as compared to first year of experimentation. Similar observation was also reported by Singh *et al.* (2012).

Moisture content was higher in the control as compared to intercropping system at all the soil depths and all the stages during summer season. The differences in moisture content in intercropping system compared to control were clearly visible before first and second irrigations. Zonation of soil moisture was determined up to 90 cm depth with the interval of 10 cm. The moisture content increased with increasing depth in both the systems (Tables 1, 2 and 3). Similar observation was also reported by Lehmann *et al.* (1998) that soil water depletion was higher under the tree row than in the alley and higher in alley cropping than in monoculture systems. Water competition between tree and crop was confirmed by the carbohydrate analysis showing lower sugar contents of roots in agroforestry than in monoculture. The agroforestry combination used the soil water between the hedgerows more efficiently than the sole cropped trees or crops, as well water uptake of the trees reached deeper and started earlier after the flood irrigation than of the sorghum, whereas the crop could better utilize topsoil water. The root system of the alley cropped acacia and sorghum exploited a larger soil

TABLE 1

Moisture content percentage in Jatropha based intercropping system and control at sowing time

Soil depth (cm)	Distance from Jatropha plants									
	1 m		% decrease over control		2.5 m		% decrease over control		Control	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
0-10	11.9	14.5	16.7	13.4	12.3	14.9	14.7	11.4	14.3	17.2
10-20	12.3	14.8	15.7	12.7	12.7	15.3	10.3	10.9	14.6	16.7
20-30	14.4	16.8	13.2	12.2	14.8	17.2	8.7	9.5	16.6	18.6
30-40	14.9	16.9	10.7	11.6	15.3	17.8	7.7	8.8	16.7	19.7
40-50	16.2	17.9	8.9	10.2	16.7	18.3	5.7	7.3	17.8	21.9
50-60	16.9	18.4	7.1	8.4	17.2	18.8	4.6	6.1	18.2	23.6
60-70	18.7	20.1	6.8	7.1	19.3	20.7	3.2	4.0	19.7	26.6
70-80	20.8	24.0	6.2	5.9	21.1	22.9	2.4	3.6	21.7	27.8
80-90	23.6	27.0	5.7	4.1	25.3	25.7	1.8	1.6	24.4	29.3
Mean	16.6	18.9	10.1	9.5	17.2	19.1	6.6	7.0	18.7	22.4

TABLE 2

Moisture content percentage in Jatropha based intercropping system and control before first irrigation

Soil depth (cm)	Distance from Jatropha plants									
	1 m		% decrease over control		2.5 m		% decrease over control		Control	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
0-10	3.6	4.2	52.4	54.5	4.1	4.6	48.3	53.6	7.9	10.2
10-20	4.5	4.8	51.1	52.7	4.5	5.8	45.6	49.6	8.7	10.9
20-30	4.8	5.4	50.2	51.0	4.9	5.2	44.8	46.7	9.6	11.2
30-40	5.3	5.9	48.6	49.3	6.1	6.4	41.6	43.2	10.6	12.4
40-50	5.9	6.4	45.3	46.4	6.6	7.2	30.8	34.4	12.3	14.1
50-60	12.7	13.5	26.1	28.6	13.2	14.6	24.6	26.4	17.1	19.4
60-70	14.1	15.3	15.3	16.8	14.6	15.1	20.8	22.5	20.4	21.7
70-80	17.2	19.6	14.7	15.9	17.9	19.0	11.7	13.2	22.4	23.2
80-90	21.2	23.6	6.3	7.4	20.3	22.9	4.2	8.3	24.3	26.1
Mean	9.9	11.0	34.4	35.8	10.2	11.2	30.3	33.1	14.8	16.6

TABLE 3

Moisture content percentage in Jatropha based intercropping system and control before second irrigation

Soil depth (cm)	Distance from Jatropha plants									
	1 m		% decrease over control		2.5 m		% decrease over control		Control	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
0-10	2.8	3.6	58.6	61.7	3.4	3.8	51.2	59.0	6.9	8.7
10-20	3.1	3.9	56.7	58.6	3.7	4.1	48.7	53.6	7.8	9.2
20-30	3.9	4.3	50.8	53.7	4.0	4.6	46.6	49.8	8.6	9.9
30-40	4.6	5.1	48.7	49.2	4.9	5.3	44.8	46.6	9.8	10.7
40-50	4.9	5.7	30.8	31.6	5.6	6.0	38.9	41.2	10.9	12.2
50-60	12.9	13.7	27.6	28.0	12.8	13.4	20.6	21.0	17.1	19.2
60-70	16.8	18.2	19.8	20.3	13.9	14.6	12.7	13.2	18.6	20.7
70-80	18.6	20.7	16.6	16.9	18.2	19.0	10.8	11.6	20.2	21.9
80-90	21.9	24.9	9.3	8.9	22.6	26.2	3.2	4.2	23.0	25.6
Mean	9.9	11.1	35.4	36.5	9.9	10.8	30.8	33.4	13.7	15.3

volume utilizing soil resources more efficiently than the respective monoculture.

Moisture content under Jatropha in the upper soil depth (0-50 cm) was about 50 per cent compared to control both before first and second irrigations during summer season. At lower depths also moisture content in agroforestry was less than control field. Per cent decrease in moisture content under Jatropha over control was higher at 1 m distance than 2.5 m distance from the trees line at all soil depths and at all the data recorded stages during both the summer seasons. Abuger *et al.* (2011) also reported that there was no significant effect of *Jatropha curcas* hedgerow distance on growth and yield of maize in the first year. In the second year, significant differences were realized in plant height, diameter, stover weight, grain weight, weight of cob and weight of seeds/cob. The closest distance from hedgerow (1 m) gave lowest plant height, diameter and stover weight. Grain weight, weight of cob, weight of seeds/ cob were lowest at 1 m. It can be concluded that closer spacing at two years would have an effect on growth and yield of maize.

It may be concluded that the moisture depletion pattern of Jatropha based intercropping system was higher at 1 m distance as compared to 2.5 m distance due to severe competition of test crops with Jatropha plantation. Maximum moisture depletion pattern was recorded up to 0-50 cm depth in both Jatropha based intercropping system and in control. However, higher moisture depletion was recorded in Jatropha based intercropping system than control. Grain yield of test crops was significantly reduced in Jatropha based intercropping system as compared to control.

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