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ACKNOWLEDGEMENTS. We thank Dr S. R. Shetye, Director, NIO, Goa and Dr V. S. N. Murty, NIO, Regional Centre, Visakhapatnam, for support and encouragement. K.M. thanks CSIR, New Delhi for providing the Senior Research Fellowship. We thank the anonymous reviewer for valuable suggestions which helped to improve the manuscript. We also thank NOAA and IMD, New Delhi for making the datasets (UOHC, storm tracks) available on their website. This is NIO contribution no. 4842.

Received 22 January 2010; revised accepted 23 September 2010

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Camelina sativa: a new crop with biofuel potential introduced in India

In the present world scenario bio-diesel has been accepted as a clean alternative fuel. Thus even before the Copenhagen Summit on climate change was held during December 2009, the participating world countries had already started fixing the mammoth targets for emission cut, which require more stringent steps in the energy sector to keep the environment clean despite maintaining good economic growth. India with its robust economic growth (8% annually) is likely to account for 15% of world's oil demand by 2040 (ref. 1). To meet such a huge demand for fuel and to realize self-reliance in energy, India is keen on a National Bio-fuel Policy, which aims to set a target of meeting about 20% blending of bio-fuels with petrol and diesel by the year 2017. Potential sources of renewable bio-fuel are bio-diesel, grain ethanol and green diesel. India's ethanol production is about 1.96 billion litres (from sugarcane molasses only), of which only 628 million litres is available for fuel purpose which translates to hardly 5% petrol blending[2]. Though the Government of India is vigorously pursuing the policy of bio-diesel from non-edible sources, specially jatropha, research on other crops with bio-fuel potential is also required to be taken up in order to have year-round supply of raw materials for commercial oil extraction from plants as well to achieve the target on time which will be environmentally compatible.

Camelina (false flax, gold-of-pleasure, *Camelina sativa* [L.] Crtz.) is an underexploited oilseed crop of the family Brassicaceae (Figure 1). It has agronomic low-input features[3] and an unusual fatty acid composition with high levels of alpha-linolenic acid[4] vis-à-vis unusually high cholesterol and brassicasterol content (188 and 133 ppm) than other vegetable oils[5]. Seed oil content of camelina has been reported between 320 and 480 g/kg and seed yield up to 2800 kg/ha (refs 6–8). Although high cholesterol and presence of eicosenoic acid (15%) pose a hurdle for its approval as food oil[9,10], the presence of omega-3 fatty acids makes its oil unique and nutritionally rich. Cold-pressed meal of camelina after oil extraction contains 10–14% oil by weight and protein (40%) with lower glucosinolate levels, making it a desirable animal feed[11]. With a variety of non-food usages of the oil as drying oil and in environmentally safe painting and coating applications[6,7], minimal agronomic input requirement for cultivation makes it a potential crop for use as bio-fuel without interfering with the edible oil trade and competition for available resources.

According to the published reports, yield potential of jatropha has been in the range of 1–10 t/ha/yr (ref. 12) depending upon the growing conditions and age of the plantation, with oil content of 30–40% and oil potential of about 1890 l/ha/yr (ref. 13). On the other hand, camelina, an annual plant with a maturity of 90–100 days, possesses 35–40% oil exhibiting a potential of 1400–1500 l/ha/yr, provided two crops are grown with an average seed recovery of 1700 kg/ha. Camelina can be used as a potential intercrop in the jatropha plantation during orchard establishment phase in North India, especially during winter months when jatropha sheds its leaves, to have a year round supply of raw materials.

Figure 1. ***a***, Camelina: thirty days after emergence. ***b***, Flowering stage.

Table 1. Performance of *Camelina sativa* cv. Calena in a polyhouse at Pithoragarh under various sowing dates

Date of sowing	Plant height at harvest (cm)	Days to harvest	Branches/ plant	Seed pods/ plant	Seeds/pod	Seed yield/ plant (g)	Seed yield (g/m^2)
June 2009	47.25	82	11.4	185.4	9.40	0.865	120.2
July 2009	47.50	84	11.6	190.8	9.80	0.970	123.5
August 2009	50.75	86	12.4	201.0	11.20	1.245	136.4
September 2009	51.50	86	12.8	203.0	13.75	1.400	150.1

In order to meet the requirement of renewable source of fuel and compliance to the policy of the Government of India for 20% blending by 2017, camelina also offers the following advantages to be a potential source of renewable biofuel:

- Good oil content in seed (40% or more).
- Low input crop with low seed requirement (3.0 kg/ha) and high multiplication ratio (average seed yield 1700 kg/ha)[6–8].
- Short-duration (90 days for seed maturity) crop to fit in any crop rotation, resulting in high cropping intensity.
- Low temperature to frost-tolerant[5].
- Fairly tolerant to weeds and grows well on relatively poor and saline soils[5].
- Palatable and nutritious meal for animals[11].

Feasibility of camelina oil as biofuel has been demonstrated by Japan Airlines (JAL) on 31 January 2009 by carrying out the world's first successful test flight of a Boeing aircraft run on biofuel from primarily a non-food energy crop, i.e. camelina (www.biofuelsdigest.com/blog2/31Jan2009).

The Defence Institute of Bio-Energy Research (DIBER) as a nodal laboratory of the Defence R&D Organisation with a programme on bio-diesel from jatropha, also started standardizing the agro-technique of camelina cultivation for its mass multiplication in hills of Uttarakhand. This will allow maximum economic utilization of winter fallow fields generally practised by the farmers in hills of Uttarakhand. Cultivation of this crop will not only sustain the economy of poor farmers in the Himalayan region, but will also provide the necessary raw stock for running the oil extraction plants year-round to meet the target of blending by 2017.

A small quantity of nucleus seed of camelina cv. Calena (EC 643910) was procured from Austria through the National Bureau of Plant Genetic Resources (NBPGR), New Delhi and the seed was multiplied successfully in low-cost naturally ventillated polyhouse at the DIBER Field Station, Pithoragarh (1700 m amsl) for further multiplication and analysis. As no record of agricultural practices was available in the literature for Indian conditions, the seeds were sown over four months to multiply for further research. Polyhouse was used to avoid crop failure as Pithoragarh receives heavy rainfall during June–August, with an average annual rainfall of 1200 mm.

Seeds multiplied at the station were sown in the 2 m long rows at monthly intervals during June–September 2009 (first week of each month). Four irrigations were given to the crop during the complete growth phase. The results of the experiments revealed the earliness of the crop (82–86 days for seed maturity) with a seed yield of 120–150 g/m^2, as shown in Table 1. The next crop is in field for multiplication of seed and further experimentation to standardize agro-technology of this crop.

The results of this preliminary study revealed that the crop has shown better adaptability to the cooler climate of hilly areas in the Indian conditions. The low yields of camelina may be attributed to the fact that the crop was grown during summer–rainy season inside the polyhouse without any fertilizer, leading to quick maturity due to high temperature compared to published reports where the crop was grown in winter–spring season allowing better growth and yield with a dry spell during harvesting[11]. After successful introduction and establishment, further studies are in progress for its utilization as bio-fuel crop in degraded lands.

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ACKNOWLEDGEMENTS. We are grateful to Dr J. Vollmann, BOKU-University of Natural Resources and Applied Life Sciences Vienna, Austria for providing the nucleus seed of Camelina cv. Calena for study and the Director, NBPGR, New Delhi for cooperation and support in custom and quarantine clearance for import of camelina seed from Austria.

Received 11 December 2009; revised accepted 13 September 2010

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