Short Note

Effects of fertilizer application on fruiting-yield of *Jatropha curcas* Linn.

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Sajiwan (*Jatropha curcas* Linn.) is one of the widely used plant species for bio-fuel production. It is a drought-resistant shrub or tree belonging to the family Euphorbiaceae, which is cultivated in Central, and South America, Southeast Asia, India and Africa (Martınez-Herrera *et al*., 2006). It can also grow out to the size of a tree as large as 12 m high (Sirisomboona *et al*., 2007).The plant is believed to be a native of South America and Africa but later distributed to other continents of the world by the Portuguese settlers (Gubitz *et al*., 1999). Katwal and Soni (2003) described that it is able to thrive in a number of climatic zones with rainfall ranging from 250 mm to 1200 mm. In Nepal, it is found in all districts of Terai, Mid-hills, and low lying areas of mountains.

The fruits of Sajiwan are used to produce bio-fuel. It reaches its maximum productivity in five years, and can live up to 50 years (Sirisomboona *et al*., 2007). It has been reported that the dry seed of Sajiwan would yield about 30–38% of crude oil using an engine-driven expeller (Forson *et al*., 2004). Acceptable thermal efficiencies of the engine are obtained with blends containing up to 50 per cent volume of Sajiwan oil (Pramanik, 2003). Multiple benefits of Sajiwan plants are not only useful in saving environmental pollution but also supports for employment generation and entrepreneurship developments.

Some studies have been carried out on raising the fruiting-yield of Sajiwan in the world. For example, pruning (Beckford, 2008) and application of chemical fertilizers (Yong *et al*., 2010; Ghosh *et al*., 2011) can increase the fruiting-yield while maintaining the same intrinsic seed-oil content, but in Nepal, limited studies have been conducted on Sajiwan, and they only deal with the socio-economic aspect of Sajiwan plantation (eg. Parajuli, 2010; Ranabhat, 2009). Meanwhile, Nepalese farmers are suffering from the poor fruiting-yield of Sajiwan. We still do not know the true factor that limits the fruiting-yield of Sajiwan in Nepal. In this context, we hypothesize that the fruiting-yield of Sajiwan in Nepal is limited due to the status of poor soil-nutrient contents. To test this hypothesis, this study was designed and different treatments (types of fertilizer) were applied in a site where the planting materials were from two different origins (i.e. seeds and branch cuttings).

Materials and methods

Study area

The trial was conducted within eight-year-old plantation of Sajiwan located at Khairenitar Village Development Committee (VDC) of Tanahun District of Nepal. The site covers 45 hectares of the land under which only 22 hectares was cultivated with Sajiwan in 2003. The elevation of the site ranges from 501 m to 505 m above mean sea level, and exhibits subtropical type of climate.

Soil characteristics of the site

Three points were selected randomly from the entire plantation site. Soil samples were collected from three different depths (0–10 cm, 10–20 cm and 20–30 cm) from the ground surface in each point. Soil analysis was carried out at soil test centre (lab), Pokhara.

Design of experiment and treatment application

The experiment was designed as two blocks of different planting materials (seedlings and branch cuttings), with seven replications of

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10 m x 10 m plots with three different treatments (control, compost, and chemical fertilizers). The trial plot was established in April 2008. Twenty kg of compost was applied to each plant in April for two years. A dose of chemical fertilizers consisting of 300 gm potassium (K_2O), 350 gm Urea, 250 gm phosphorus (P_2O_5, DAP), 30 gm Boron and 30 gm Zinc was applied to each plant as a treatment of chemical fertilizers. Insecticides were sprayed uniformly to all blocks before flowering and fruiting to protect from insect damage.

Data collection and analysis

One row was selected randomly in each plot. Counting of fruits was done in each plant on the selected rows in July 2010. Two-way ANOVA was used to test whether there was significant difference in the average fruiting yields between blocks (seedling and branch cutting) and among treatments (control, compost, chemical fertilizer) at 5% level of significance. Multiple comparisons (LSD test) were done to find out the best treatment type.

Results and discussion

Soil features

The soil in the research site was found to be very poor in nutrient contents, and was alkaline i.e. pH 7.81. Nitrogen content in the top layer up to 10 cm was found to be high whereas potassium, boron and zinc were low (Table 1). The constituents of the chemical nutrients in the soil were: 2.51% organic matter, 0.12% available nitrogen, 48.78 kg/ha available phosphorus (P_2O_5), 889.78 kg/ha available calcium, 17.56 kg/ha available potassium (K_2O), 0.46 ppm available boron, and 0.35 ppm available zinc.

Table 1: Soil characteristics

Parameter	Soil depth: (0–10 cm)	Soil depth: (10–20 cm)	Soil depth: (> 30 cm)
Soil pH	Alkaline	Alkaline	Alkaline
OM (%)	Moderate	Low	Low
N (%)	High	Medium	Low
Phosphorus	Low	Low	Low
Potassium	Low	Low	Low
Calcium	High	High	High
Boron	Low	Low	Low
Zinc	Low	Low	Low

Fruiting-yield on the basis of types of planting material

Fruiting yields of Sajiwan varied according to the types of planting materials (seedlings and branch cuttings). The maximum number of fruits in the plants originated from the seedlings was found to be 312 whereas it was 357 in those originated from the branch cuttings (Table 2). Similarly, the mean number of fruits of the plants established using branch-cuttings was 46 fruits per tree whereas that of the plants established using seedlings was 28 per tree; the pooled average yield of fruits per plant being 36. The variation of the fruiting yields in the plants originated from branch cuttings was 1.6 times higher than that of the seedling-originated plants. This may be due to the fact that the plants propagated from stem-cuttings established quickly and start producing fruits faster (Heller, 1996; Gosh and Singh, 2010). The plants propagated from stem-cuttings are also more competitive for nutrients, because they have more lateral roots than those from the plants originated from seeds (Heller, 1996). Kochhar and Kochar (2008) also observed that the plants propagated from stem-cuttings were able to grow faster and produce more fruits in the first year as compared to the ones propagated from seeds, which is in line with the findings of this study.

Prajapati and Prajapati (2005) found that fruiting-yield of Sajiwan per tree ranged from 1.2 kg under rain-fed condition to 3.2 kg under irrigated condition. Similarly, a study conducted in Florida estimated as 25–42 pounds (11–19 kg) of seeds per shrub per year (Beckford, 2008), but the yield of present study (0–0.85 kg; calculated from table 2 where 1 fruit = 3 seeds, and oven dry weight of a seed=0.79 gram which was obtained from the measurement of this study) was found to be too low as compared to the above mentioned studies. The reason could be due to the effect of less availability of water and nutrients (Achten *et al*., 2010; Laviola and Dias, 2008; Yong *et al*., 2010; Abdrabbo *et al*., 2009), un-adapted provenances (Heller, 1996; Tewari *et al*., 2007) and other site factors *viz*. soil conditions, altitude, sunlight and temperature (Ghosh *et al*., 2007; Openshaw, 2000).

Fruiting-yield in the plants originated from seedlings

The mean number of fruits of the plants yield in the control plot was 21. Similarly, the mean number

Table 2: Fruiting-yield on the basis of the types of planting material

Types of plants	Total no. of plants	No. of fruits/plant		
		Min	Max	Average
Originated from seedlings	220	0	312	28
Originated from branch-cuttings	172	0	357	46

of fruits with the application of compost and chemical fertilizer were 29 and 34 respectively (Fig. 1). This indicates that the mean fruiting-yield was increased by 38% with the application of compost and by 62% with the application of chemical fertilizers; however, statistically there was no significant difference in the mean fruiting-yield with the application of compost and chemical fertilizers (Fig. 1). The duration of our study might not be enough to get significant difference in the annual fruit-production per tree grown from the seedlings as the seedlings take longer time to get mature (Heller, 1996; Gosh and Singh, 2010) and also less competitive for nutrients (Heller, 1996).

Fruiting-yield in the plants originated from branch cuttings

The mean number of fruits of the plants developed from branch-cuttings in control, compost and chemical fertilizer used plots were 34, 43 and 65 respectively (Fig. 1). This shows that the mean fruiting-yield was increased by 26% with the application of compost and by 91%

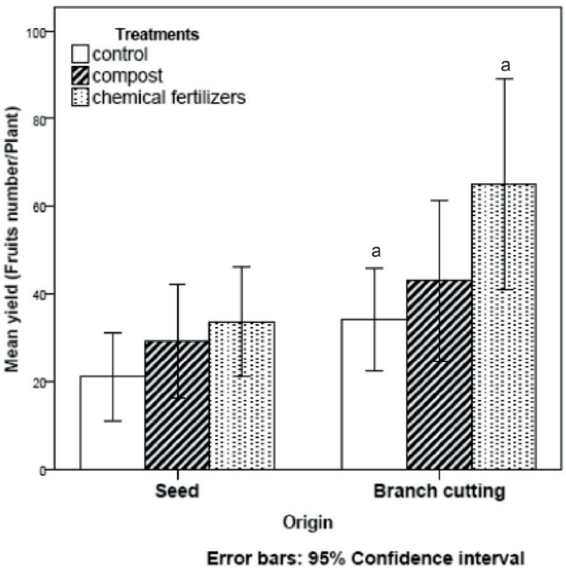

Fig. 1. Fruiting-yield in the plants originated from seeds and branch cuttings with different treatments. Errors bars correspond to 95% level of confidence intervals. The letter 'a' indicates significant differences (p<0.01) according to multiple comparison LSD test.

with the application of chemical fertilizers. The statistical test showed the significant difference in mean yield. While performing the multiple comparisons (LSD), only the average fruiting-yields of treatment pairs i.e. control and chemical fertilizer treatments differed significantly (Fig.1). This may be due to the fact that chemical fertilizers are soluble and immediately available to the plants. Therefore, the effect of chemical fertilizer is usually direct and fast. There is a surprising evidence that fruiting-yield of Sajiwan can even be increased by 330% (3.3 fold) with the use of 6-benzyladenine (160 ml/lit) (Bang and Zeng, 2011).

Conclusion

The research concludes that the fruiting-yield of Sajiwan in the study area was very low, and varied with the mode of regeneration. Fruiting-yield in the plants originated from seedlings did not vary significantly even with the treatments they received, but it differed significantly with the application of chemical fertilizers in the plants established from branch-cuttings. This may be due to the fact that plants established from seedlings takes more time to get maturity than the plants established from branch cuttings. Therefore, caution must be provided when the result is generalized.

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