Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 1177-1180

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Effect of apical pruning and foliar spray of potassium nitrate on seed yield and oil content of *Jatropha curcas* L. in agroclimatic zone of Jharkhand

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Abstract
This experiment was conducted to study the effect of apical pinching and foliar spray of potassium nitrate on the five year old plant at Nagri field, 7 km away from the Institute of Forest Productivity, Ranchi, Jharkhand during 2016-2017. Nine treatments (three doses of potassium nitrate combined with each of three doses of pinching off treatments) with two replications in spit-plot design experiment was used. The maximum fruits and seeds number per plant (398.00 fruits/plant and 860.75 seeds/plant) was found in Treatment-6 (Pinching of 10 cm with foliar spray of 2% potassium nitrate) and least (192.00 fruits/plant and 359.25 seeds/plant) in Treatment-8 (Pinching of 5 cm with foliar spray of 4% potassium nitrate). The maximum oil content (56.19%) was reported from the treatment-9 (Pinching of 10 cm with foliar spray of 4% potassium nitrate) and least (37.81%) was found in the Treatment-4 (only foliar spray of 4% potassium nitrate). Higher concentration of potassium nitrate increases the oil content and decreases the yield and lower concentration increases the yield with constant oil content.

Keywords: *Jatropha curcas*, Prunning, Potassium Nitrate, Oil Percentage and Yield

Introduction
Jatropha curcas is a small tree or shrub nearly 3-6 m in height and belongs to family euphorbiaceae which is less dependent on climate and soil condition, grow well in all types of soil, even in poor and degraded lands and cultivated easily with minimum need of care. It propagates in sustainable pattern which bears nuts within 18 months and productive for 30 years. *Jatropha curcas* is native of Maxico and Central America, yet it provides alternative source of energy in most of the places of world which are sustainable, profitable and none polluting.

There was no interest in *Jatropha* before two decades. Recently the increasing in environmental awareness due to the global warming and climate change are occurring, caused by fossil fuels, government is trying to begin use the renewable and environmental friendly fuel sources such as Jatropha. The oil of Jatropha seeds is known for its medicinal value (Wei *et al.*, 2005) and used as a source of lamp oil and producing soap (Chikara, 2007). Presently, oil of *Jatropha* seeds has been recognized for its suitability for conversion into biodiesel (Solomon, 2002). It is an ideal plant for biodiesel and their biodiesel blended with petrodiesel can serve as an alternate fuel.

Jatropha is one of the important plant species which is recognized as most potential species for biodiesel production and seed contains high oil content (30 to 38%). It can be easily propagated by seeds or cuttings and can be grown in different land use situations (Forson *et al.*, 2004). It starts bearing within 2 to 3 years and can be commercially exploited in 4 to 5 years and lasts for about 50 years (Gubitz *et al.*, 1999). Harinder *et al.*, (2008) reported that the seeds of *Jatropha* contain about 300–350 g kg^{-1} oil, which can be used as a fuel directly or, in its transesterified form, as a substitute for diesel. The seed has a hard, black outer shell containing a white kernel. The proportions of shell and kernel range from 350 to 400 g kg^{-1} and from 600 to 650 g kg^{-1} respectively. Large-scale planting of *Jatropha* has taken place or is planned in India, China, Madagascar, Myanmar and many other developing countries, with the aim of using the oil as biodiesel (Francis *et al.*, 2005). The main objective of this research work is to find out the effect of apical pinching and foliar spray of potassium nitrate on seed yield, oil content and flowering cycle of *Jatropha curcas* L. in agroclimatic zone of Jharkhand.

Materials and Methods

The research work were done at Nagri field 7 km away from the Institute of Forest Productivity, Ranchi (Latitude: $23^0$21.388' N and Longitude: $85^0$14.661' E) and height of elevation is 685 meters from sea level. The experimental field contains red acidic soil and the average annual rainfall is about 1200 mm. The experiment was done on 5 year-old *Jatropha* plants. There were the nine treatments with two replications in spit-plot design experiment. The nine treatments combination (three doses of potassium nitrate combined with each of three doses of pinching off treatments) was applied during April to June, 2016 as shown in Table 1. The pinching off or removal of apical buds of entire terminal shoots were done at 0, 5 and 10 cm from tip of the shoots. The pinching application was done at pre-bloom stage during last week of March; 2016. Foliar spray of KNO_3 (0, 2 and 4%) were done twice. The first application of KNO_3 was done during the first week of April 2016. The second application was made at 20 days after the first application. In the next year, the application of foliar spray of KNO_3 (0, 2 and 4%) were also done twice. But the first application of KNO_3 was done during the first week of May 2017 and second application was done during the first week of June 2017. 150 ml of working solutions of various concentrations per meter of canopy diameter was sprayed on the branches of *Jatropha* plants. The fertilizer application like Urea (60 g/plant), DAP (55 g/plant) and MOP (40 g/plant) were done during last week of June 2017. The fruit harvesting was done during the September, 2017.

Fig 1: Spraying of Potassium Nitrate

Fig 2: Foliar Spray of Potassium Nitrate

Table 1: Three doses of potassium nitrate combined with each of three doses of pinching off treatments.

Treatments	Pinching off (cm)	KNO_3 (%)
T_1	0	0
T_2	5	0
T_3	10	0
T_4	0	2
T_5	5	2
T_6	10	2
T_7	0	4
T_8	5	4
T_9	10	4

Seed preparation for oil extraction

The seeds of *Jatropha curcas* L. were collected from the study areas of experimental field. After the seeds were collected, they were dried in open sun light till their moisture content become constant. After that some seeds were cracked and their shells were carefully removed to obtained karnel as shown in Figure-5. The big size karnel was cut into size of small pieces which are suitable and prepared for oil extraction procedure (Figure-6).

Oil extraction procedure

The soxhlet apparatus was used as shown in Figue-1 for the extraction of oil. For oil extraction, 10 to 20 g of crushed seed karnel of *Jatropha* seed was wrapped in a filter paper and non absorbent cotton and placed inside the thimble chamber of Soxhlet extractor. A round bottom flask containing petroleum ether was fixed to the extractor. 200 ml of petroleum ether was measured and poured into the round flask. The condenser was also used to condense the evaporating solvent and the solvent back into Soxhlet extractor. After 6 to 7 hours of heating, the petroleum ether and extracted oil was separated from solid waste product of Karnel seed and the petroleum ether was removed from extracted oil by heating the mixture to evaporate the petroleum ether solvent. The oil content was obtained at the end of experiment. The oil percentage was calculated through a formula as shown in equation-1.

Oil percentage = Weight of oil extracted (g)/Weight of crushed karnel seed (g) X 100--------1

Fig 3: Fruits on experimental plant

Fig 4: Seeds of *Jatropha curcas*

Fig 5: Karnel portion of seed

Fig 6: Small pieces of Karnel portion

Fig 7: Soxhlet apparatus setup used during oil extraction

Fig 8: Oil content in flask

Results and Discussions

The main problem with *Jatropha* plant was the irregular flower and fruiting which creates the problem during the fruit harvesting. Due to treatment of pinching off, no flowering was observed in the current season except in control. However, 2-3 new shoots were emerged from each pinched off branch. Hegazi *et al*., (2011) were found that there are no significant differences between the treatment in the first season, while potassium nitrate sprays at 4% and 2% are significantly increased the number of leaves per shoot in second years. During the second year, this experiment was showed that it required less time to complete the flowering and fruiting cycle. The application of pruning and foliar spray of Potassium Nitrate was more or less solved the problem of irregularities of flowering and fruiting cycle.

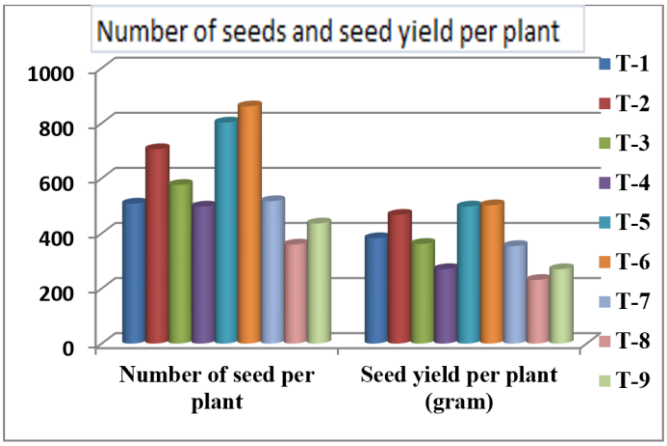
From the results in the Table-2, the maximum fruits and seeds number per plant (398.00 fruits/plant and 860.75 seeds/plant) was found in Treatment-6 (Pinching of 10 cm with foliar spray of 2% potassium nitrate) followed by Treatment-5 (358.00 fruits/plant and 802.00 seeds/plant), Treatment-2 (307.75 fruits/plant and 705.25 seeds/plant), Treatment-3 (294.33 fruits/plant and 575.67 seeds/plant) and least two treatment was Treatment-8 (192.00 fruits/plant and 359.25 seeds/plant) and Treatment-9 (212.00 fruits/plant and 435.75 seeds/plant) which were less number of fruits and seeds than Treatment-1 (Control). It was found that pruning of *Jatropha* plant branches was increased the number of branches and optimised the number of the fruits and seeds of per plant while higher concentration of Potassium Nitrate solution was spray on foliar part of plant may be reduced the fruits and seeds yield of *Jatropha* plant. Diwakar *et al.*, (2017) found that the appropriate canopy management by pruning supported with fertilizer application under different growing condition of siliviculture system can obtain large number of branches (sprouts) for maximum production of fruits.

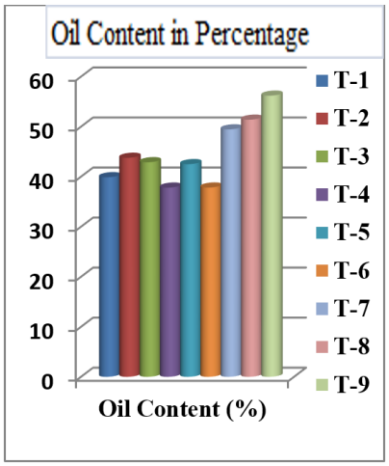
The maximum seeds yield was found in Treatment-6 **(**501.82 gram/plant**)** followed by Treatment-5 (497.34 gram/plant), Treatment-2 (467.05 gram/plant). It was also found that the seeds yield of Treatment-1 (control) was 382.27 gram/plant which was higher than the Treatment-3 (361.37 gram/plant), Treatment-7 (353.78 gram/plant), Treatment-4 (270.00 gram/plant), Treatment-9 (269.73 gram/plant) and least was found in Treatment-8 (230.68 gram/plant). From the above results, it was also concluded that foliar spray at higher concentration (4%) of potassium nitrate (KNO_3) decreased the production yield of Jatropha plant while increased the yield at lower concentration (2%). Fangary (1998), Mostafa and Saleh (2006) and Sarrwy *et al*., (2012) were found that spraying of potassium using different forms had a positive effect on yield as number or fruits weight of citrus trees. Latest report of Yousef *et al.*, (2016), the fruit yield of Jatropha expressed as weight (kilogram per tree) was significantly increased in all different spraying treatments as compared with control.

The *Jatropha* plant is generally cultivated for the purpose of oil extraction and the main source of oil is seeds of *Jatropha* plant. After the seeds yield, oil percentage was one of the important parameter of this research paper. The maximum oil content (56.19%) was reported from the treatment-9 (Pinching of 10 cm with foliar spray of 4% potassium nitrate) followed by Treatment-8 (51.39%) and Treatment-7 (49.45%). However, the accepted average oil content was found in Treatment-2 (43.77 %), Treatment-3 (42.88%) and Treatment-5 (42.50%). The least oil content was found in the Treatment-4 (37.81%) and Treatment-6 (37.82%) which was less oil content than control (39.89%).

Table 2: Shows the average yield per plant and oil percentage

Treatment	Average number of fruits/plant	Average number of seeds/plant	Average weight of 40 seeds (g)	Average seed yield per plant (gram)	Average oil Percentage (%)
T_1	240.75	507.75	30.12 ± 0.78	382.27	39.89 ± 1.82
T_2	307.75	705.25	26.49 ± 0.47	467.05	43.77 ± 3.71
T_3	294.33	575.67	25.11 ± 0.28	361.37	42.88 ± 0.06
T_4	255.75	497.00	21.73 ± 1.33	270.00	37.81 ± 5.62
T_5	358.00	802.00	24.81 ± 0.18	497.34	42.50 ± 2.58
T_6	398.00	860.75	23.32 ± 2.83	501.82	37.82 ± 1.58
T_7	250.00	516.75	27.39 ± 0.02	353.78	49.45 ± 4.12
T_8	192.00	359.25	25.69 ± 0.71	230.68	51.39 ± 6.33
T_9	212.00	435.75	24.76 ± 2.47	269.73	56.19 ± 1.39





From the above graphs, it can conclude that oil content was increased with application of high concentration of potassium nitrate solution during the foliar spray. The concentration of 4% potassium nitrate was optimised the oil content in *Jatropha* seeds while the fruits and seeds production was decreased. However, the 2% concentration of potassium nitrate solution was not effective in the oil content while it was increased in the production of fruits and seeds of *Jatropha* plant. The similar finding were reported by Yousef *et al.*, (2016) that KNO_3 spraying enhanced fruit yield and seed physical and chemical characteristics compared with control *Jatropha* plant. Higher concentration of potassium nitrate increases the oil content and decreases the yield and lower concentration increases the yield with constant oil content.

Conclusions

From the above results, it can be concluded that apical pruning with Foliar Spray of Potassium Nitrate had a positive effect on improvement of seed yield and oil content. The maximum fruits and seeds number per plant **(**398.00 fruits and 860.75 seeds) was found in Treatment-6 (Pinching of 10 cm with foliar spray of 2% potassium nitrate) and least (192.00 fruits and 359.25 seeds) in Treatment-8 (Pinching of 5 cm with foliar spray of 4% potassium nitrate). The maximum oil content (56.19%) was reported from the treatment-9 (Pinching of 10 cm with foliar spray of 4% potassium nitrate) and least (37.81 %) was found in the Treatment-4 (only foliar spray of 2% potassium nitrate). The best treatment to increase the number of fruits and seeds per plant was under the pruning with foliar spray of potassium nitrate at 2% twice and the maximum oil content was obtained under the pruning with spraying potassium nitrate at 4% twice.

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