Indian Farming 75 (12): 81-83; December 2025

From weed to feed: Role of Lantana biochar in chickpea productivity

Roshan Choudhary[1]*, S. K. Sharma[2], B. L. Dudwal[1] and Shivani Meena[3]

[1]*Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan 303 329*

[2]*Indian Council of Agricultural Research, New Delhi 110 012*

[3]*Agriculture Supervisor, Government of Rajasthan, Jaipur, Rajasthan 302 012*

Indian agriculture has made significant progress in achieving self-sufficiency in food grain production and has attained a growth rate sufficient to meet the demands of the growing population. Although the production of pulses has increased in the past decade, it has not kept pace with the growing population. Since pulses are a major source of protein in the Indian diet, as well as resource-conserving and environmentally friendly, enhancing their production can help address challenges such as nutritional security and reduction of dependence on imports.

Keywords: Environmentally friendly, Pulses, Resource-conserving

LANTANA *camara*, a widespread invasive weed, can be sustainably repurposed as biochar, a potent soil amendment. Lantana, ranked among the top 10 invasive species globally, poses significant threats to biodiversity, public health, and livestock. Recent field experiments reveal that Lantana biochar significantly improves chickpea growth, yield, and soil health, transforming a problematic weed into a valuable resource for sustainable agriculture. Its biomass, however, presents an opportunity: When processed into biochar through slow pyrolysis, it yields a carbon-rich soil amendment with high porosity and nutrient retention characteristics. Chickpea (*Cicer arietinum* L.), a key pulse crop, stands to benefit from improved soil quality and nutrient availability facilitated by biochar amendments.

Biochar production and application protocols

Lantana biochar was produced through slow pyrolysis using a biochar production system (Pratap Kiln) developed at CTAE, Udaipur. Stalks of *Lantana camara* were fed into the pyrolysis reactor under oxygen-limited conditions, where the temperature reached up to 450°C for a duration of four minutes. The process involved three stages: In the first stage, the moisture content of the biomass was reduced to below 10% at around 180°C; in the second stage, biochar formation began with the decomposition of hemicellulose and cellulose within the temperature range of 180–360°C; and in the final stage, lignin decomposition occurred at approximately 450°C. In field experiments, biochar doses of 1.5, 2.5, and 3.5 t/ha were compared, with split application (50% at sowing and 50% at branching) found optimal for chickpea productivity.

Description of chemical composition of *Lantana camera*

Lantana camara contains a wide range of chemical constituents. Its essential oils are primarily composed of monoterpenes and sesquiterpenes such as sabinene, eucalyptol, caryophyllene, and humulene, along with triterpenoids, steroids, alkaloids, and flavonoids.

Table 1. Mineral composition of *Lantana camara*

Minerals	Composition (ppm)
Phosphorus (P)	0.07 ± 0.01
Cacium (Ca)	0.53 ± 0.01
Manganese (Mn)	0.98 ± 0.03
Sulphur (S)	0.74 ±0.02
Potassium (K)	1.06 ± 0.03
Iron (Fe)	0.83 ± 0.02
Magnesium (Mg)	0.43 ± 0.03
Copper (C)	0.54 ± 0.01

Agronomic effects on chickpea

Growth and yield enhancement:

Doses of lantana biochar: In the present investigation, the application of 3.5 t/ha lantana biochar resulted in a significantly higher seed yield of 1436 kg/ha, representing a 34.51% increase over the control (1067 kg/ha). Similarly, haulm yield was significantly enhanced with 3.5 t/ha lantana biochar, recording 3523 kg/ha, which was 50.02% higher than the control (2348 kg/ha). The maximum biological yield of 4959 kg/ha was also achieved with 3.5 t/ha lantana biochar, whereas the minimum biological yield (3416 kg/ha) was observed under the control treatment.

Stages of application: Application of Lantana biochar at different crop growth stages resulted in a significant improvement in seed yield (1386 kg/ha), haulm yield (3334 kg/ha), and biological yield (4720 kg/ha) compared to its application only at the time of sowing. This enhancement may be attributed to greater nutrient availability throughout the crop growth period, as biochar was applied in split doses. The split application extended the duration of nutrient supply and improved the soil's water-holding capacity due to the porous structure of Lantana biochar. These combined effects enhanced crop growth and led to an increased number of pods per plant, ultimately resulting in higher seed, haulm, and total biological yield of chickpea.

Table 2. Effect of application of lantana biochar on chickpea

Treatments	Number of effective Nodules/plant	Number of branches/ plant	Number of pods/plant
Doses of lantana biochar (t/ha)			
Control	16.23	8.58	65.99
1.5	17.99	9.44	71.72
2.5	19.65	10.20	77.66
3.5	20.40	10.60	82.60
S.Em±	0.483	0.184	1.899
C.D. at 5%	1.395	0.532	5.484
Stages of application			
At sowing	16.07	8.71	66.55
At branching	19.28	9.92	75.64
At pod formation	18.22	9.61	74.44
50% at sowing + 50% at branching	20.69	10.57	81.35
S.Em±	0.483	0.184	1.899
C.D. at 5%	1.395	0.532	5.484

Table 3. Effect of application of lantana biochar on yields of chickpea

Treatments	Seed yield (kg/ha)	Haulm yield (kg/ha)	Biological yield (kg/ha)
Doses of lantana biochar (t/ha)			
Control	1067	2348	3416
1.5	1216	2897	4113
2.5	1365	3382	4717
3.5	1436	3523	4959
S.Em±	25.81	72.03	74.25
C.D. at 5%	74.56	208.05	214.46
Stages of application			
At sowing	1161	2762	3922
At branching	1279	3057	4337
At pod formation	1258	2997	4255
50% at sowing + 50% at branching	1386	3334	4720
S.Em±	25.81	72.03	74.25
C.D. at 5%	74.56	208.05	214.46

Soil health

Different doses of Lantana biochar have been shown to significantly increase the availability of nitrogen and phosphorus in soil. The highest available nitrogen was recorded with the application of 3.5 t/ha Lantana biochar compared to the control. Specifically, available nitrogen and phosphorus increased by 5.41% and 9.35%, respectively, over the control; these improvements were statistically similar to results seen with the application of 2.5 t/ha Lantana biochar. Soil dehydrogenase and microbial biomass also improved, indicating boosted soil biological activity. Biochar minimizes the nitrogen losses by reducing the leaching losses, increasing the bioavailability, higher nitrogen fixation. Thus from the above findings, it is clear that biochar application improves the chemical and biological properties of soil in a long term.

Table 4. Effect of application of lantana biochar on soil microbial biomass in soil after crop harvest

Treatments	Bacteria (106)	Fungi (104)	Bacteria (105)
Doses of lantana biochar (t/ha)			
Control	63.15	22.95	34.45
1.5	68.59	24.13	37.82
2.5	74.41	26.36	41.11
3.5	75.61	26.69	41.31
S.Em±	0.757	0.268	0.500
C.D. at 5%	2.187	0.774	1.443
Stages of application			
At sowing	63.09	22.74	34.62
At branching	71.65	25.48	39.65
At pod formation	71.08	24.82	39.26
50% at sowing + 50% at branching	75.94	27.07	41.17
S.Em±	0757	0.268	0.500
C.D. at 5%	2.187	0.774	1.443

Economic analysis

The highest net returns were obtained for 3.5 t/ha Lantana biochar (₹ 53,672/ha) and for split application (₹ 59,028/ha), proving the economic advantage of biochar adoption in chickpea cultivation.

Environmental benefits

Utilizing *Lantana camara* for biochar production helps control its invasive spread, reduces ecological damage, and recycles a problematic weed into a valuable resource for sustainable agriculture and soil management. Utilizing *Lantana camara* for biochar production provides multiple environmental benefits:

- It helps control the invasive spread of Lantana, preserving native biodiversity and preventing ecological damage caused by dense thickets and allelopathic effects.
- Converting Lantana into biochar mitigates health risks associated with the plant (such as skin irritation and respiratory issues) by stabilizing toxic compounds through pyrolysis.
- Lantana biochar effectively adsorbs pharmaceutical pollutants like acetaminophen from wastewater, addressing water contamination issues and aligning with sustainable development goals for clean water and health.

View of field experiment

Effect of lantana biochar on number of effective nodules at 45 DAS

- The biochar acts as a carbon sink, contributing to carbon sequestration, which helps mitigate climate change.
- This approach provides a renewable, eco-friendly solution that recycles a problematic invasive species into a valuable product for soil amendment, environmental remediation, and water treatment.

Mechanisms behind productivity gains

Soil physical and chemical improvements: Lantana biochar amendments improve soil water retention, cation exchange capacity, and porosity due to the biochar's particulate, porous nature. It also increased nutrient availability and retention in soil, particularly nitrogen and phosphorus, enhance root and shoot growth in chickpeas.

Microbial and biological impacts: Biochar supports beneficial soil microflora (bacteria, fungi, and actinomycetes), vital for nutrient cycling and plant health. These biological changes translate into greater pod development and seed weight, directly impacting yield.

Application strategies and recommendations: The evidence strongly supports using Lantana biochar at 3.5 t/ha, ideally split between sowing and branching stages for chickpea. Split dosing increases the period of nutrient availability, improving chickpea yield parameters versus single, one-time application.

Broader implications and future directions

Repurposing *Lantana camara* as biochar provides a dual benefit: weed management and soil fertility enhancement for sustainable intensification of chickpea agriculture. This approach aligns with broader goals of organic and resilient farming systems, offering pathways for reducing dependence on chemical fertilizers and improving smallholder livelihoods.

SUMMARY

Application of 3.5 t/ha lantana biochar resulted in the highest seed yield (1436 kg/ha, a 34.5% increase over control), haulm yield (3523 kg/ha), and total biological yield (4959 kg/ha). Split application (50% at sowing + 50% at branching) significantly increased yield compared to single dosing, owing to sustained nutrient availability. Lantana biochar transforms a widespread weed into a feeder for sustainable agriculture. Its integration into chickpea farming systems boosts plant productivity, soil fertility, and farm profitability, providing an innovative, eco-friendly solution for weed utilization and crop enhancement.

*Corresponding author email: roshan.agro@sknau.ac.in