Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(6): 1932-1936
Received: 29-08-2020
Accepted: 11-10-2020

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Evaluation of Dhaincha (*Sesbania aculeata* L.) accessions for green manuring traits and soil fertility improvement

T Shobha Rani, Ch Ramulu, T Sukruth Kumar and P Jaganmohan Rao

Abstract
Dhaincha is an important green manuring crop having established significance since ancient times. Identification of a Dahincha variety with superior green manuring traits is needed in Telangana state. Ten accessions of Dhaincha (*Sesbania aculeata* L.) were collected from different parts of India and characterized in Complete Randomised Block Design with three replications on the basis of the traits affecting green manuring and soil fertility status after incorporation at 45 DAS. Fresh weight (g/plant) was found to be significantly higher in NTPD 08 (56.3 g) followed by NTPD 04 (52.3 g), NTPD 10 (49.3 g) and NTPD 09 (48.3 g). Highest biomass on dry weight basis was observed in NTPD 09 (25.7 g), followed by NTPD 08 (24.3 g), NTPD 04 (23.0 g) and NTPD 01 (21.7 g). The maximum number of root nodules was found in NTPD 08 (79) and NTPD 04 (74). Highest reduction in soil pH recorded in NTPD 04 (3.3%), whereas, highest increase of Electrical conductivity of the Soil (dS/m) was recorded with NTPD 08 (18.18%). Increase in Organic carbon (OC) content (%) observed with NTPD 04 (11.8%) followed by NTPD 08 (11.1%). Similarly, increase in available nitrogen was highest in NTPD 08 (4.7%) followed by NTPD 04 (4.2%), available phosphorus (kg/ha) in NTPD 05 (3.3%) and NTPD 07 (3.3%) and available potassium (kg/ha) in NTPD 04 (4.9%) followed by NTPD 02 (4.8%). Study revealed NTPD 04 & NTPD 08 found superior for green manuring traits.

Keywords: *Sesbania aculeata* L., Dhaincha, biomass, soil fertility, green manuring

Introduction
India's food production is more than quadrupled during last 50 years as a consequence of Green Revolution, making country self-sufficient. However, green revolution has resulted in many adverse effects on natural resources such as decline in soil health, deficiency of major and micro-nutrients, energy crises, stagnation in yield and ecological-environmental imbalance. In this context, green manuring may play a vital role in minimizing the ill effect of intensive cropping system and judicious use of fertilisers. Before the advent of mineral fertilizers, green manuring was considered as an indispensable practice in crops like rice, sugarcane, potato, wheat, mustard etc (Mandal *et al*., 2003) [8]. However, with easy availability of chemical fertilizers and intensive cropping systems, practice of green manuring was almost given up. In recent years, with an indication of declining trend/constant trend in productivity due to continuous use of only chemical fertilizers (NPK), there has been revival of interest in green manuring. At present, about 6.3 million hectares of area is estimated to be under green manuring in the country. Green manuring with legume crops enriches soil N due to fixation of atmospheric N by symbiotic bacteria. The decomposing green manuring has a solubilising effect on NPK and micro-nutrient in soil. It also reduces leaching and gaseous losses of N to increase the use-efficiency of plant nutrients. Green manuring helps not only in augmenting soil nutrient supply system but also improve physical, chemical and biological conditions of soil. Leguminous crops are largely being used as a green manure due to their high symbiotic nitrogen fixation.

Among green manuring crops, *Sesbania aculeata* L. is one of the most important crops and its incorporation in the soil adds about 60-80 kg nitrogen/ha (Paikary *et* a/., 2001) [11]. Sesbania green manure after decomposition, increases humus, available nitrogen and lower down the C:N ratio of soil. In real sense, this green manure crop improves soil structure, aeration, permeability and also protect the soil from leaching of nutrients, The crop also helps in conservation of soil moisture, prevent the weed growth and reduce the incidence of diseases and residual effects of persistent chemicals. Green manuring also enhance the boron and iron content in soil. Decomposed materials of sesbania also serve as chelating compound and helps in increasing the availability of nutrients i.e. Zn, Cu, Mn etc. in succeeding crop (Sanjeev kumar *et al.*) [9].

Sesbania green manure improves soil health, environmental health and human health, resultant adulteration of our food chain can also be minimized through green manuring (Boparaj *et al.*, 2009) [3]. Keeping in view the above facts, the present study was undertaken with an objective to study the effect of different accessions of Sesbania green manure incorporation on fertility status. Further identification of suitable variety with superior green manuring traits and seed yield is needed for Telangana state.

Materials and Methods

The experiment was carried out at the Agricultural Research Station, Nathnaipally, Central Telangana Zone, Professor Jayashankar Telangana State Agricultural University, Telangana State, India during June to August 2018. Ten *Dhaincha* accessions were collected (preselected based on their biomass yield) from different locations of India were used as experimental materials along with the check (local available seed). These accessions include, NTPD 01 (Utterpradesh), NTPD 02 (Rajasthan), NTPD 03 (Patancheru), NTPD 04 (Bihar), NTPD 05 (Andhrapradesh), NTPD 06 (Karnataka), NTPD 07 (Maharashtra), NTPD 08 (Punjab), NTPD 09 (Bangalore), NTPD 10 (Gujrath). The experiment was laid out in Complete Randomized Block Design with three replications. The treatment combinations of different *Dhaincha* accessions were incorporated and checked at 45 days after sowing. The plot size was 4.0 x 2.7 m with spacing of 45 x 20 cm. *Dhaincha* accessions were sown on June 19, 2018. At 45 DAS, observations on Plant Height, Number of Branches per plant, Number of Root nodules per plant, Fresh weight per plant and Dry weight per plant were recorded. The 45 days old *Dhaincha* plants were incorporated into soil as green manure and allowed to decompose. Soil samples were collected before sowing (initial) and one month after decomposition of *Dhaincha* biomass and analyzed for chemical properties in Soil Testing Laboratory, Regional Agricultural Research Station, PJTSAU, Warangal Telangana, India following standard analytical procedures such as pH and EC were determined in 1:2 :: soil: water suspension using glass electrode (Jackson 1967) [5] and systronics conductivity bridge (Richards 1954) [12], respectively. Organic C was determined by rapid titration method (Walkley and Black 1934) [16], available nitrogen by alkaline permanganate method (Subbaiah and Asija 1956) [14], available phosphorus by Olsens method (Olsen *et al*., 1954) [10], available potassium by ammonium acetate extraction method (Jackson 1973) [6].
Data was analyzed by simple statistical methods such as mean, range, CV and CD (5%) following using AGRISTAT computer package.

Results and Discussion

The present investigation was carried out during the year *Kharif*, 2018 to identify the suitable variety of *Sesbania aculeata* L. on improving soil fertility. The experimental findings obtained in present study due to evaluation of different accessions are discussed vividly in the light of scientific explanation;

Soil pH was slightly reduced by incorporation of Sesbenia green manure in all the accessions at 45 days. Initial soil pH observed was 7.64 to 7.96. After green manuring with respective accessions range observed was 7.47 to 7.88. Range of percent reduction observed was 1.0% (NTPD 02) to 3.3% (NTPD 04). Highest reduction recorded in NTPD 04 (3.3%) followed by NTPD 06 (3.2%), NTPD 01(2.8%) and NTPD 03(2.8%). The reduction in soil pH by Sesbania green manure incorporation might be due to the fact that the Sesbania leaves sap has a pH value of 4.0 and being strongly acidic in nature. After decomposition, it exerts a marked influence in neutralizing the high pH of soil due to production of organic acids. The present result is in conformity to Adekiya *et al.*, 2019 [1].

Electrical conductivity of the Soil (dS/m), adding organic matter such as green manure, increases EC by adding cations and anions or either increasing or diluting available salts and nutrients. In present experiment before green manuring EC ranged from 0.21 to 0.27 dS/m. While it was slightly increased to 0.24 to 0.33 dS/m with per cent increase of 10.34 (NTPD 03) to 18.18% (NTPD 08). Increase percent was highest in NTPD 08 (18.18%) followed by NTPD 04 (16.67%), NTPD 01(14.29%) and NTPD 10 (14.29%) compared to the check (13.79%) (Azeez and Van, 2012) [2].

Organic carbon content (%) was significantly improved by incorporation of Sesbania green manure test entries (6.7 to 11.8%) over check. Soil organic carbon is a measureable component of soil organic matter. Organic matter makes up just 2–10% of most soil's mass and has an important role in the physical, chemical and biological function of agricultural soils (Boparaj *et al.*, 2009) [3]. Soils in Telangana state are very low to low in organic carbon. Experimental site initially consisted of 0.40 to 0.48% and green manure incorporation increased OC to 0.43 to 0.54%. Improvement recorded was low, it was mainly due to soil samples were taken immediately after decomposition and OC expected to increase over long run during crop growth period. Overall, Per cent improvement ranged from 6.7% in NTPD 05 to 11.8% in NTPD 04. Thus highest increase was noticed after incorporation of NTPD 04 (11.8%) followed by NTPD 08 (11.1%) (Sugino *et al*., 2013) [13].

Photo 1a: Incorporation of Dhaincha accessions at 45 days after sowing at ARS, Nathnaipally during Kharif 2018.

Photo 1b: Decomposition of Dhaincha accessions at 45 days after sowing at ARS, Nathnaipally during Kharif 2018.

Available nitrogen is nitrogen in a chemical form that can be readily absorbed by plant roots. A tacit assumption is that the nitrogen is present within the root zone. Available Nitrogen (kg/ha) was improved by different accessions of Sesbania green manure incorporation at 45 days, but per cent was less *i.e.*, ranged 2.4% (NTPD 02) to 4.7% (NTPD 08). However in Telangana state, soils found to contain low to moderate available nitrogen content. Similarly initial available nitrogen content of experimental site ranged from 196 to 211 kg/ha and slight increase was observed as 201 to 217 kg/ha. Among all the accessions highest improvement was noticed in NTPD 08 (4.7%) followed by NTPD 04 (4.2%), while it was 2.8% in check (Golam Sarwar *et al*., 2017) [4].

Available phosphorus (kg/ha): was significantly influenced by Sesbania Green Manure incorporation. Moderately high phosphorous levels observed in experimental site. The initial maximum availability of P in soil was ranged from 20.6 to 21.6 kg/ha. After incorporation of Dhaincha accessions at 45 days resulted in slight increase in available phosphorous levels 21.2 to 22.3 kg/ha. P availability in soil may be attributed due to mineralization of green biomass in soil and solubilisation of inorganic unavailable compound present in soil by increased microbial population. In this experiment range of percent increase in available phosphorous was reported as 2.8 to 3.3%. Highest increase was observed in NTPD 05(3.3%) and NTPD 07 (3.3%), while it was least in NTPD 04 (2.8%), NTPD 09 (2.8%) and Check (2.8%) (Kisinyo *et al*., 2012) [7].

Available potassium (kg/ha) was markedly improved by Sesbania Green Manure Incorporation at 45 days with different accessions. The extensive root system of green manure crops improved the physical condition of the soil and liberated $C0_2$ and organic acids, which help in dissolving native potassium in soil and thereby increases the availability of potassium. Native soil initially consisted available potassium in range of 204 to 256 kg/ha. After incorporation it was increased with range of 211 to 262 kg/ha and per cent increase noticed was 2.1 to 4.9%. Accession NTPD 04 recorded highest available phosphorous per cent increase followed by NTPD 02 (4.8%) (Sujatha *et al*., 2017) [15].

Green manuring traits

Various green manuring traits of *Sesbania aculeata* L. *viz*., plant height, number of root nodules, green biomass, dry weight of biomass and visual observations were recorded before incorporation at 45 DAS. Significant differences were observed in all ten Dhaincha accessions over check (Table 2). Significantly taller plants were observed in NTPD 08 (108.7 cm) followed by NTPD 110 (101.5 cm), NTPD 109 (99.1 cm) and NTPD 101(96.1 cm). Check grown up to 82.4 cm. Similarly, significantly higher number of branches noticed in NTPD 08 (5.6), NTPD 05 (5.4) and NTPD 04 (5.1) compared to the check (4.2). The maximum number of root nodules ranged from 61 to 79. Significantly high number of root nodules found in NTPD 108 (79) followed by NTPD 04 (74), NTPD 101 (68), NTPD 09 (65).

Fresh weight/ biomass (g/plant) significantly high in NTPD 08 (56.3 g) followed by NTPD 04 (52.3 g), NTPD 10 (49.3 g) and NTPD 09 (48.3 g). Similarly, highest biomass on dry weight basis was observed in NTPD 09 (25.7 g), followed by NTPD 08 (24.3 g), NTPD 04 (23.0 g) and NTPD 01 (21.7 g). Range observed in all the accessions was 26.3 to 56.3 g and 16.3 to 25.7 g for fresh weight and dry weight respectively. However check recorded 36.3 g of fresh weight and 17.2 g dry weight for biomass.

Table 1: Evaluation of Dhaincha accessions on soil fertility status at Agricultural Research Station, Nathnaipally during *Kharif*, 2018

S. No.	Genotype	pH			EC (dS/m)			OC (%)			Avl. N(kg/ha)			Avl. P_2O(kg/ha)			Avl. K_2O(kg/ha)		
		Before GM	After GM	% Decr.	Before GM	After GM	% Incr.	Before GM	After GM	% Incr.	Before GM	After GM	% Incr.	Before GM	After GM	% Incr.	Before GM	After GM	% Incr.
1	NTPD 01	7.84	7.62	2.8	0.24	0.28	14.29	0.43	0.47	8.5	206	213	3.3	21.6	22.3	3.1	228	239	4.6
2	NTPD 02	7.96	7.88	1.0	0.26	0.30	13.33	0.42	0.45	6.7	201	206	2.4	20.9	21.6	3.2	219	230	4.8
3	NTPD 03	7.94	7.72	2.8	0.26	0.29	10.34	0.43	0.45	4.4	206	212	2.8	21.1	21.8	3.2	236	246	4.1
4	NTPD 04	7.96	7.70	3.3	0.25	0.30	16.67	0.45	0.51	11.8	203	212	4.2	20.7	21.3	2.8	234	246	4.9
5	NTPD 05	7.71	7.56	1.9	0.24	0.27	11.11	0.41	0.44	6.8	198	203	2.5	20.6	21.3	3.3	204	211	3.3
6	NTPD 06	7.78	7.53	3.2	0.23	0.26	11.54	0.46	0.50	8.0	196	201	2.5	20.9	21.6	3.2	236	241	2.1
7	NTPD 07	7.64	7.47	2.2	0.21	0.24	12.50	0.40	0.43	7.0	199	205	2.9	20.8	21.5	3.3	256	262	2.3
8	NTPD 08	7.83	7.62	2.7	0.27	0.33	18.18	0.48	0.54	11.1	202	212	4.7	21.1	21.8	3.2	231	242	4.5
9	NTPD 09	7.84	7.63	2.7	0.25	0.29	13.79	0.44	0.48	8.3	195	201	3.0	21	21.6	2.8	226	236	4.2
10	NTPD 10	7.89	7.74	1.9	0.24	0.28	14.29	0.46	0.50	8.0	208	214	2.8	21.2	21.9	3.2	241	249	3.2
11	Check(L)	7.71	7.88	2.2	0.25	0.29	13.79	0.47	0.51	7.8	211	217	2.8	20.6	21.2	2.8	228	236	3.4

Table 2: Evaluation of Dhaincha accessions for green manuring traits at Agricultural Research Station, Nathnaipally during *Kharif.*, 2018

S. No.	Genotype	Plant Height at 45 days (cm)	No. of Branches / plant at 45 days	No of Root nodules/ plant	Fresh weight at 45 days (g/plant)	Dry weight at 45 days (g/plant)
1	NTPD 01	96.1*	5.0	68*	41.3	21.7*
2	NTPD 02	85.3	3.6	64	30.3	17.0
3	NTPD 03	73.3	2.7	63	26.3	16.3
4	NTPD 04	95.3*	5.1*	74*	52.3*	23.0*
5	NTPD 05	79.3	5.4*	61	32.0	18.3
6	NTPD 06	82.9	4.3	62	29.3	19.0
7	NTPD 07	55.0	3.7	62	20.0	18.3
8	NTPD 08	108.7*	5.6*	79*	56.3*	24.3*
9	NTPD 09	99.1*	3.6	65*	48.3*	25.7*
10	NTPD 10	101.5*	4.9	63	49.3*	21.3
11	Check(L)	82.4	4.2	64	36.3	17.2
	Mean	87.2	4.2	65.9	39.7	20.8

	Range	55.0 - 108.7	2.7- 5.6	61-79	26.3 - 56.3	16.3 - 25.7
	CV	12.7	8.6	9.3	8.6	9.2
	CD(5%)	12.8	0.9	3.0	11.8	4.3

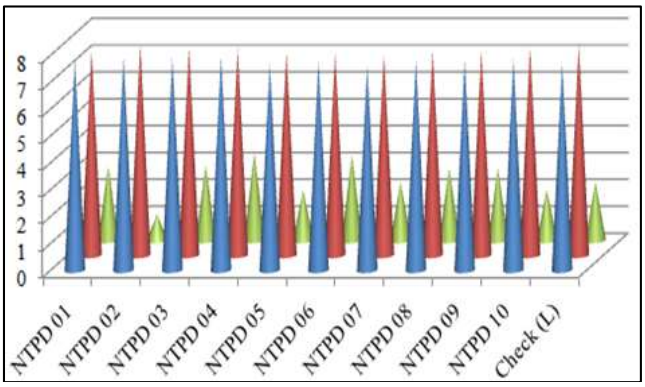

Fig 1a: Effect of Green-manuring on Soil pH

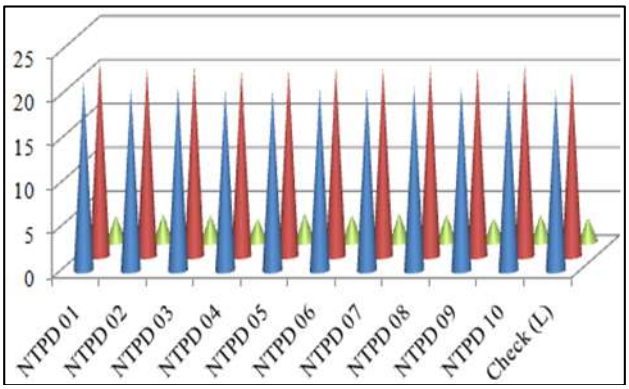

Fig 1e: Effect of Green-manuring on Avl. P_2O_5(kg/ha)

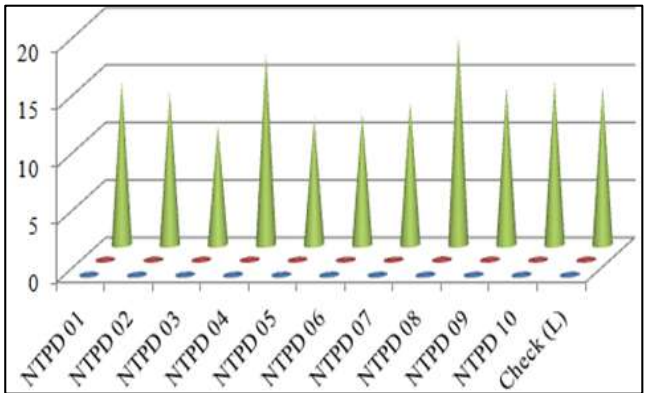

Fig 1b: Effect of Green-manuring on EC (dS/m)

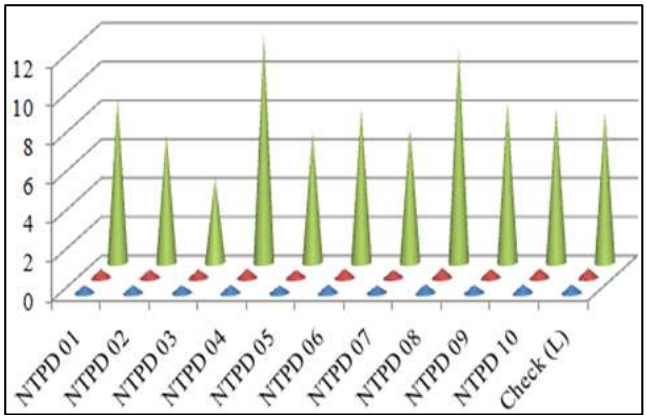

Fig 1c: Effect of Green-manuring on OC (%)

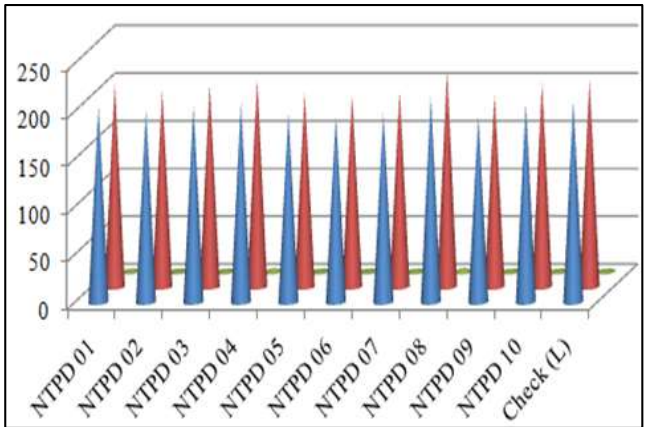

Fig 1d: Effect of Green-manuring on Avl. N(kg/ha)

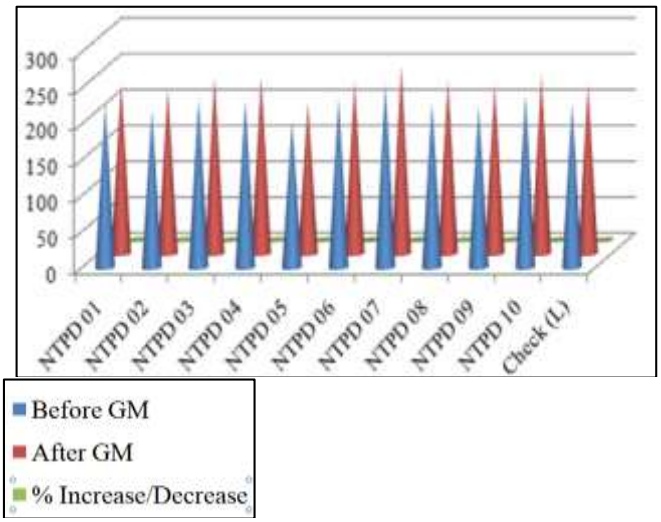

Fig 1f: Effect of Green-manuring on Avl. K_2O(kg/ha)

Conclusion

The present study revealed, among the ten accessions of Dhaincha (*Sesbania aculeata* L.) evaluated for green-manuring traits, NTPD 08 followed by NTPD 04 found superior. The entries may be evaluated for seed production in *Kharif*, *Rabi* and *Summer* seasons for further inclusion in seed chain.

Acknoledgement

This work is ostensibly supported by Dr. Jagdeeshwar, Director of Research for funding at Agricultural Research Station, Nathnaipally, Central Telangana Zone, Professor Jayashankar Telangana State Agricultural University, Telangana State, India and I thank him for continuous support. I also thank anonymous referees for their usual suggestions.

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