Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 2349-2351
Received: 04-05-2018
Accepted: 08-06-2018

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Role of Neem and Poplar biochar for the growth and yield of wheat (*Triticum aestivum* L.) under poplar (*Populus deltoides*) based agroforestry system

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Abstract
An experiment was carried out in the Forestry research farm, Department of Silviculture and Agroforestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during the *rabi* season 2017-2018. An experiment was laid out in a Randomized Block Design (RBD) with ten treatments and three replications and each plot size is $4m^2$. The crop was applied with recommended dose of fertilizer with neem biochar and poplar biochar at five different doses (0%, 5%, 10%, 15%, 20%). Out of all the treatments T_4-(Recommended dose of fertilizer +Neem Biochar 15%) was found to be best treatment followed by T_9 –(recommended dose of fertilizer+ 15% of poplar biochar) results revealed that there was significant difference from 30th day to 120th day and parameters are plant height (97.95 cm), number of tillers per plant(8.78), plant dry weight(129.31gm), length of panicle (14.20 cm), number of grains per panicle (25.66), grain yield (27.73 q ha^{-1}), straw yield (63.32 q ha^{-1}) and harvest index (54.90 %).

Keywords: agroforestry, neem biochar, poplar biochar, wheat, RDF

Introduction
Agroforestry Nair (1993) [4] is the intentional integration of trees and/or shrubs into crop and animal production. Agroforestry systems appeal to a triple bottom line value approach to provide ecological, social and economic benefits; they are designed to complement the characteristics and management objectives of a given site to provide multiple benefits. Objectives can include; revenue generation, conservation, ecosystem services, ecosystem restoration, increased efficiency, economic diversification and/or moderation of financial risk. Indicators of success are determined according to the management objectives of the site. Agroforestry practices are widely recognized in the tropics and are gaining increased recognition in temperate regions such as BC. In North America, there are 6 main agroforestry practices that take advantage of the interactive benefits of combining trees and shrubs with crops and/or livestock to create integrated and sustainable land-use systems.

Wheat is the most important food crop under agroforestry system in North Indian states, which accounted 88.31 million tones production in 2011-12. In India, it is widely intercropped cereal crop during rabi season (November-April) with Poplar, (Sarvade *et al.*, 2014) [5] Eucalyptus and other fast growing short rotation tree species in Uttarakhand, Punjab, Haryana, U.P and Bihar states in north-and-parts of central and eastern states of M.P, Chhattisgarh and W.B. The micro-climate under agroforestry is modified by trees, under such conditions; ecosystems. Its role in the light of combating hunger, the growth response of under story wheat crop may be different from sole cropping system.

India ranks second in terms of total wheat production in the world with a production of 68.55 million from an area of 27 million ha. India alone produces 13% of the world's wheat production. Although all the 4 species; *Triticum aestivum* (Bread-wheat), *Triticum durum* (Macaroni - wheat), *Triticum dicoccum* (Emmer –wheat) and *Triticum spherococcum* (Dwarf wheat) are grown in India. The main wheat species under cultivation are *Triticum aestivum* and *Triticum durum* of which the former occupies a large area.

Biochars is a kind of carbonaceous materials by incomplete combustion of biomass materials under anaerobic or oxygen-limited conditions. Biochar has the features of high carbon content, high stability, abundant surface functional groups, multiple porosity, high specific surface area and cation exchange capacity and so on, which could be used as the adsorbents for heavy metals and organic pollutants in soil and water. Biochars could be produced from much biological resources, including forest residues, agricultural waste, urban waste, yard waste and

and soon. Neem seed active substance extracted residues (NSASER) was belonging to agricultural waste, and so it could be regarded as a raw material to be used to prepare biochars. Biochar application in addition to fertilizer addition can lead to plant growth benefits, but a negative effect is sometimes observed without fertilization, due to reduced bio-availability, through sorption of nitrogen In addition, the effect may be short lasting: (Chan *et al.,* 2007) [1]. Jeffery *et al.,* (2011) [3] Biochar may alter the physical properties of the soil, including increasing aeration and water holding capacity of certain soils. Biochar can increase pH by 0.5–1.0 unit in most cases for application rates of 30 Mg ha of biochar, nutrients are directly available through the solubilisation of ash in the solid biochar residue and other nutrients may become available though microbial utilization of a small labile carbon component of biochar.

Materials and Methods

The field experiment was carried out in the Forestry research farm, Department of Silviculture and Agroforestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during the *rabi* season 2017-2018. Which is located at 25˚C 45'N latitude, 81˚85' E longitude and at an altitude of 98 m above mean sea level (MSL). The average annual rainfall is about 102cm with maximum concentration during July to September. The experiment consisted of 9 treatments and 3 replications with recommended dose of fertilizer of wheat and 5 different concentrations of neem biochar and poplar biochar (0%, 5%, 10%, 15%, 20%) laid out in Randomized Block Design (RBD). The seeds was sown with seed rate of 100 kg/ha with row spacing 25cm. sowing method is line sowing. Required plant population was maintained by thinning out at 25 DAS and 45 DAS. Weeding, irrigation, pesticide application, threshing were done under requisite. The crop was matured in 120 days. Pre harvest observations are plant height, number of tillers per plant, plant dry weight (gm) and post harvest parameters are length of panicle (cm), number of grains per panicle, grain yield (q ha^{-1}), straw yield(q ha^{-1}) and harvest index(%) were statistically analyzed and critical difference were calculated.

Table 1: Role of Neem and Poplar biochar for the growth of wheat (*Triticum aestivum* L.) under poplar (*Populus deltoides*) based agroforestry system.

Treatments	Plant height (cm) 120 DAS	Number of tillers per plant	Plant dry weight(gm)	Length of panicle (cm)
T_1: RDF+ neem biochar 0%	91.60	7.09	118.60	10.09
T_2: RDF+ neem biochar 5%	93.75	8.06	123.32	11.66
T_3: RDF+ neem biochar 10%	95.96	8.16	127.32	12.32
T_4: RDF+ neem biochar 15%	97.95	8.78	129.31	14.20
T_5: RDF+ neem biochar 20%	93.04	7.34	120.64	10.46
T_6: RDF+ poplar biochar 0%	86.31	6.48	113.32	9.13
T_7: RDF+ poplar biochar 5%	92.71	7.61	118.33	10.80
T_8: RDF+ poplar biochar 10%	95.25	7.88	121.90	12.43
T_9: RDF+ poplar biochar 15%	96.21	8.35	127.84	13.33
T_{10}: RDF+ poplar biochar 20%	91.73	7.47	116.05	10.25
F test	S	S	S	S
sEd (±)	0.60	0.31	1.32	0.67
CD at 5%	1.27	0.66	2.80	1.42

DAS- Days After Sowing, RDF- Recomended Dose Of Fertilizer

Table 2: Role of Neem and Poplar biochar for the yield of wheat (*Triticum aestivum* L.) under poplar (*Populus deltoides*) based agroforestry system.

Treatments	Number of grains per panicle	Grain yield (q ha^{-1})	Straw yield(q ha^{-1})	Harvest index (%)
T_1: RDF+ neem biochar 0%	21.33	22.76	58.67	37.81
T_2: RDF+ neem biochar 5%	22.33	24.10	59.38	40.81
T_3: RDF+ neem biochar 10%	23.00	26.16	61.73	42.39
T_4: RDF+ neem biochar 15%	25.66	27.73	63.32	54.90
T_5: RDF+ neem biochar 20%	21.66	23.50	59.61	39.42
T_6: RDF+ poplar biochar 0%	19.00	19.97	40.25	34.64
T_7: RDF+ poplar biochar 5%	22.33	22.68	59.98	38.79
T_8: RDF+ poplar biochar 10%	24.00	25.30	60.81	42.34
T_9: RDF+ poplar biochar 15%	24.66	26.80	62.91	43.84
T_{10}: RDF+ poplar biochar 20%	22.66	20.56	59.34	42.62
F test	NS	S	S	NS
sEd (±)	6.04	0.62	4.90	5.41
CD at 5%		1.32	10.38	

DAS- Days After Sowing, RDF- Recomended Dose of Fertilizer

Results and Discussion

Growth attributes

Data pertaining to growth attributes are presented in table 1, which revealed that the growth attributes like plant height (97.95 cm), number of tillers per plant (8.78), plant dry weight (129.31), length of panicle 14.20 cm) was recorded statistically significant with the treatment T_4: RDF+ neem biochar 15% results were reported with Gebremedhin *et al.,* (2015) [2].

Yield attributes

As given in second table, the number of grains per panicle (21.33), grain yield q/ha (22.76) are significantly higher with the treatment T_4: RDF+ neem biochar 15%. The similar

findings were reported by Sharma *et al.*, (1996) [7]. Straw yield q/ha (63.32), harvest index % (54.9) were also recorded higher under the same treatment. These results are very close with the findings of) Sharma *et al.*, (2000) [6].

Conclusion

From the above findings, it can be concluded that the treatment T_4: RDF+ neem biochar 15% was recorded significantly higher growth and yield attributes of wheat.

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