International Journal of Farm Sciences **6(4):** 188-192, 2016

Effect of different fertility levels and plant spacing on growth and yield of Sarpgandha (*Rauvolfia serpentina* (L) Benth Ex Kurz under poplar-based agroforestry system

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ABSTRACT

Non-timber forest products (NTFPs) species-based agroforestry system is one of the most promising land management systems helping the most expeditious enhancement product per unit area on sustainable basis. The NTFPs support the rural economy and have been used to improve rural livelihood security. *Rauvolfia serpentine* is an indigenous medicinal herb of Indian continent having multiple influences on environment, biodiversity, rural economy, health and culture. Apart from traditional use in healthcare and culture it has been increasingly used in pharmaceutical industries in the country as well as abroad. During recent years farmers of eastern and western Uttar Pradesh have started the cultivation of Sarpgandha under agroforestry system using suitable management practices. A study was conducted in the research plot of School of Forestry and Environment, SHIATS, Allahabad, UP under the project 'Standardization of techniques for cultivation of Sarpgandha under poplar-based agroforestry system' sponsored by CST, Lucknow, UP during 2009-11. Three spacing S_1 (45 x 30 cm), S_2 (45 x 45 cm) and S_3 (45 x 60 cm) and four levels of inorganic fertilizers F_1 (N_{15} P_{20} K_{15}), F_2 (N_{30} P_{40} K_{30}), F_3 (N_{45} P_{60} K_{45}) and F_4 (N_0 P_0 K_0 kg/ha) were used in the experiment. Perusal of data showed that treatment spacing S_2 (45 x 45 cm) with inorganic fertilizer F_3 (N_{45} P_{60} K_{45}) was found to be superior over other treatments.

Keywords: Alkaloids; agroforestry; poplar; Sarpgandha; fertilizer; spacing

INTRODUCTION

Global market for medicinal plants has been growing and capitalizing on the growing awareness of herbal and aromatic plants worldwide. *Rauvolfia serpentine* (L) Benth Ex Kurz (Apocyanaceae) is an indigenous medicinal herb of Indian continent having multiple influences on environment, biodiversity, rural economy, health and culture. Apart from traditional use in healthcare and culture it has been increasingly used in pharmaceutical industries in the country as well as abroad.

It has been categorized as an endangered species based on the IUCN Red Data Book and critically endangered in CAMP 2001 report (Bhattarai et al 2002). It is widely distributed in the foothills of Himalayan range up to an elevation of 1300-1400 m and in the sub-Himalayan tract from Punjab eastwards to Nepal, Sikkim and Bhutan, in Assam in the lower hills of Gangetic plains, eastern and western Ghats, in some parts of central India and in Andaman. A climate with temperature range of 10 to 38°C is well suited for the growth of plant. Best areas for its growth are those which combine high rainfall (1500-4000 mm) with proper drainage of the soil such as slight slopes (Sumy et al 2000).

The tuberous roots of Sarpagandha provide more than 30 alkaloids. Out of these reserpine, serpentine, reserpeninun, rauvolfinine, deserpidine and recinamine are of great importance. It is used in Ayurveda, Siddha and Yunani sciences of medicines for the treatment of high blood pressure, insomnia, cardiac diseases and a number of mental problems such as psychic disorders, mental retardation, epilepsy, agitation and neurotic disorders. In southeastern Bihar and the tribal areas of Jharkhand the powder of Sarpagandha roots is used for the treatment of snakebites or snake poisoning. Root decoction and leaves are given to cure snakebite in Satar tribe of Morang and Jhapa districts (Siwakoti and Siwakoti 2000). Extracts of the roots are valued for intestinal troubles; aqueous decoction of root is given to cattle in diarrhoea (Dey 1998). The antihypertensive effects shown by various preparations of the drug are attributed to alkaloids especially reserpine-rescinnamine group; these effects are probably through the depletion of tissue stores of catecholamines from peripheral sites; the sedative and tranquillizing properties of the drug are thought to be related to depletion of catecholamine and serotonin from the brain (Handa et al 1999, Pushpangadan 2008). The forest areas in Uttar Pradesh are very rich in varieties of medicinal plant species particularly in the Vindhyan region where various medicinal plants grow naturally (Kamalahar 2010).

Poplar is produced in industrial plantations in more than 70 countries. It is now grown in smallholder agroforestry systems in many tropical countries. Farmers of various parts of India are adopting agroforestry practices with incorporation of medicinal plants and other crops for high return from their farm. The Indian farming has reached its high end with the use of chemical fertilizers (Agnihotri and Mohan 2012). Keeping this in mind the experiment was carried out under different fertility levels and plant intensity to achieve maximum yield of Sarpgandha under poplar-based agroforestry system.

MATERIAL and METHODS

The investigation was carried out in the research plot of School of Forestry and Environment, SHIATS, Allahabad, UP

under the project 'Standardization of techniques for cultivation of Sarpgandha under poplar-based agroforestry system' sponsored by CST, Lucknow, UP during 2009-11 for screening the effect of different inorganic fertility levels as well as plant stocking on *R serpentina* to find out the association between morphological parameters and yield attributes under poplar-based agroforestry system. The experimental site was situated at an elevation of 98 m amsl at 28°87' N latitude and 81°15' E longitude having a sub-tropical climate with extremes of summer and winter. The crop was grown under normal season.

Three spacing S_1 (45 x 30 cm), S_2 (45 x 45 cm) and S_3 (45 x 60 cm) accommodating 0.75, 0.5 and 0.38 lakh plants per hectare respectively and four levels of inorganic fertilizers F_1 (N_{15} P_{20} K_{15}), F_2 (N_{30} P_{40} K_{30}), F_3 (N_{45} P_{60} K_{45}) and F_4 (N_0 P_0 K_0 kg/ha) were used in the experiment. Dry matter yield was determined by drying stems, leaves and root samples of Sarpagandha in a forced drought oven at 70°C for 24 hours to constant weight. The experiment was laid out in (3 x 4) factorial design with three replications. The recorded data were finally worked out on hectare basis. The data were subjected to statistical analysis appropriate to the design and significance of different sources of variations was tested by Fisher's and Snedecor's F-test at probability level of 0.05 (Chandel 1984) to obtain information on the mean performance and to assess the association between yield and its components as well as capital use efficiency.

For field data the experiment was laid out in completely randomized block design (CRBD) replicated 5 times. In each replication 5 culms were selected and data were recorded and subjected to statistical analysis of variance as suggested by Fisher and Yates (1963). The significance and non-significance of the treatment effect were judged with the help of 'F' variance ratio test.

RESULTS and DISCUSSION

Data given in Table 1 show that maximum root length (43.333 cm) was found in F_3 (N_{45} P_{60} K_{45} kg/ha) followed by 40.555 cm in F_2 (N_{30} P_{40} K_{30} kg/ha). There were non-significant differences in root length among different fertilizer and spacing interactions. Maximum fresh root weight (100.000 g) was recorded in F_3S_2 (N_{45} P_{60} K_{45} kg/ha, 45 x 45 cm). Fresh shoot weight was also maximum (96.333 g) in F_3S_2 (N_{45} P_{60} K_{45} kg/ha, 45 x 45 cm) which was at par with F_2S_2 (N_{30} P_{40} K_{30} kg/ha, 45 x 45 cm) (96.000 g). Dry root weight was maximum (54.333 g) in F_3S_2 (N_{45} P_{60} K_{45} kg/ha, 45 x 45 cm) followed by F_2S_2 (N_{30} P_{40} K_{30} kg/ha, 45 x 45 cm) (50.333 g). Dry shoot weight (45.000 g) was also recorded in F_3S_2 (N_{45} P_{60} K_{45} kg/ha, 45 x 45 cm) which was at par with 44.333 g in F_3S_1 (N_{45} P_{60} K_{45} kg/ha, 45 x 30 cm).

Table 1. Impact of spacing and inorganic fertilizer on growth characteristics of Sarpagandha (*Rauvolfia serpentina*) under popular-based agroforestry system after 24 months

Parameter	Level of fertilizer	Spacing				F-test	SE (d)	$CD_{0.05}$	
		S_1	S_2	S_3	Mean				
Root length (cm)	F_0	35.333	35.667	34.667	35.222	Fertilizer	*	0.3383	0.2392
	F_1	36.667	39.667	35.333	37.222	Spacing	**	0.293	0.2072
	F_2	40.000	44.333	37.333	40.555	Interaction (Fertilizer x Spacing)	**	0.586	0.4144
	F_3	44.333	45.333	40.333	43.333				
	Mean	39.083	41.250	36.917					
Fresh root weight (g)	F_0	63.667	73.800	45.067	60.845	Fertilizer	5.4801	2.6418	1.868
	F_1	51.667	73.800	63667	62.334	Spacing	4.7459	2.2878	1.6177
	F_2	77.333	96.667	60.000	78.000	Interaction (Fertilizer x Spacing)	9.492	4.5757	3.2355
	F_3	81.667	100.000	81.000	87.556				
	Mean	68.584	85.534	62.434					
Fresh shoot weight (g)	F_0	75.533	75.333	43.733	64.866	Fertilizer	*	0.9608	0.6794
	F_1	63.333	76.667	66.000	68.667	Spacing	*	0.8321	0.5884
	F_2	69.333	96.000	71.000	78.778	Interaction (Fertilizer x Spacing)	*	1.6642	1.1768
	F_3	80.667	96.333	80.333	85.778				
	Mean	72.217	86.083	65.267					
Dry root weight (g)	F_0	25.000	37.667	24.667	29.111	Fertilizer	*	2.3152	1.6371
	F_1	32.667	43.333	29.333	35.111	Spacing	*	2.005	1.4178
	F_2	40.000	50.333	45.667	45.333	Interaction (Fertilizer x Spacing)	*	4.0101	2.8356
	F_3	48.333	54.333	46.667	49.777				
	Mean	36.500	46.416	36.583					
Dry shoot weight (g)	F_0	32.333	30.667	32.000	31.667	Fertilizer	*	0.6545	0.4628
	F_1	34.000	33.667	35.000	34.222	Spacing	*	0.5668	0.4008
	F_2	35.103	40.667	41.333	39.034	Interaction (Fertilizer x Spacing)	*	1.1337	0.8016
	F_3	44.333	45.000	34.333	41.222				
	Mean	35.442	37.500	34.667					

*Significant, **Non-significant, S_1= 45 x 30 cm, S_2= 45 x 45 cm, S_3= 45 x 60 cm, F_1= N_{15} P_{20} K_{15} kg/ha, F_2= N_{30} P_{40} K_{30} kg/ha, F_3= N_{45} P_{60} K_{45} kg/ha, F_4= N_0 P_0 K_0 kg/ha,

The demand of Sarpgandha is increasing rapidly for medicinal utility round the globe. Inorganic fertilizers and plant intensity (spacing) has a great potential in this field. Replacing traditional practices, systematic agricultural activities can play a significant role in maintaining the status of environment. From study it was found that treatment F_3S_2 (fertilizer N_{45} P_{60} K_{45} kg/ha, spacing 45 x 45 cm) was superior over other treatments under poplar-based agroforestry system contributing to higher yield attributes.

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Received: 8.9.2016 ***Accepted: 2.11.2016***