KUSUM (*SCHLEICHERA OLEOSA* (LOUR.) OKEN) SEED GERMNATION AND SEEDLING GROWTH AS AFFECTED BY INTEGRATED NUTRIENT MANAGEMENT UNDER ACID SOIL OF JHARKHAND

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Abstract
Not only seed germination, but also slow growth of the plant is a problem for raising plantation for lac cultivation and/or for other purposes. An experiment was laid out to generate information, if plant growth promoting rhizobacteria (PGPR) inoculations can increase germination percent of kusum seeds. At the same time, effort was made to see whether integration of PGPR (azotobactor, phosphobacterin and vassicular arbuscular mycorrhizae) and recommended dose of chemical fertilization (NPK @ 38-12-36 mg/ polytube) could increase seedling growth satisfactorily. Experiment was conducted in Randomized Block Design in factorial mode. By the end of the rainy season, Azotobacter, Phosphobacterin and VAM registered a mean reduction in germination to the tune of 9.5, 12.7 and 7.5 percent over control. Seedling mortality was not affected significantly due to any of the PGPRs. Application of chemical fertilizers reduced seedling survival 6 percent and basal shoot diameter 9 percent, respectively. But, its application could bring a remarkable change in mean tap root length and shoot dry weight of kusum seedlings in the month of February. Phosphobacterin proved to be the most significant factor affecting seedling growth. Shoot and root weight were affected the most; forty four and 46 percent reduction in weight was observed as compared to control. VAM affected seedling growth moderately and its effect was observed on shoot diameter, shoot dry weight and leaf dry weight. Maximum reduction was observed on leaf dry weight (31 percent). Interaction study in majority of cases showed that interaction of factors in its lowest level of application (control) performed the best followed by condition when applied in highest levels. Thus, a combination of no fertilizer application and no phosphobacterin inoculation performed as good as a combination of fertilizer application and phosphobacterin inoculation. Concerned bacteria/ micro-organisms of the PGPR treated seeds might have consumed sugar/ amino acids which might have led to a decrease of the germination processes. The study recommends to go for inoculation of PGPR after completion of germination.
Key words: Schleichera oleosa, azotobacter, phosphobacterin, VAM, germination, growth

Introduction

Kusum (*Schlechera oleosa*) is an important lac host. It is found in abundance in Jharkhand, M.P., Orissa, Chhattisgarh, Maharastra, Gujarat, A.P. and several other lac growing states of this country. In fact, *kusum* tree produces the best quality *kusmi* lac. Besides, *kusumi* lac, the tree produces *kusum* fruits which are eaten by tribal community by and large. Seed of the fruit is the source of industrial oil. At the end of the season, seeds are collected by local traders (*pykars*) from local markets and supplied to industries. On an average seeds are sold @ 15-30 rupees/Kg.

In majority of cases, *kusum* plants are multiplied through seed. It is a wild species and germination of the seeds shows a very much erratic bahaviour. There could be so many reasons for this erratic behaviour. Factors to consider can range from climatic, genetic, physiological, soil characteristics, microbial interaction, dormancy, time of sowing etc and many more. Its a great challenge to plant Scientists to identify the actual reason behind poor seed germination of this tree species.

Not only seed germination, but also slow growth of the plant is a problem for raising plantation for lac cultivation and/or for other purposes. Physiology of the plant is not very much responsive to inputs provided to the plant. Many a times, it is very much sensitive to small amount of root damage during transplanting. It leads to mortality during transplanting.

Role of plant growth promoting rhizobacteria (PGPR) is well known for promoting seed germination and seedling growth. The genus *Azotobacter* is a common nitrogen fixing bacterium. It secrets vitamins, amino acids, sidephores and auxins. *Azotobacter* produces indole acetic acid *(IAA),* gibberllic acid (GA) which are important plant growth hormones and these hormones help in seed germination and plant growth considerably. There are evidences of quality fruit production in litchi with its application (Lembisana et al 2014)

Mycorrhiza is a mutualistic association between fungi and higher plants. The extrametrical fungal hyphae can extend several centimeters into the soil and absorb large amounts of nutrients for the host root. Mycorrhizal fungi form a bridge between the roots and the soil, gathering nutrients from the soil and giving it to the roots. Nopamornbodi et al 1987 estimated that mycorrhizal plants accumulated higher quantity of macro and micro nutrients including P, K, Ca, Cu and Mn in the leaf.

Efficiency of P fertilizer throughout the world is around 10 - 25 %, and concentration of bio-available P in soil is very low reaching the level of 1.0 mg $kg.^{-1}$ soil. Phosphate Solubilizing Bacteria (PSB) solubilize the unavailable forms of inorganic P like tricalcium, iron, aluminum and rock phosphates into soluble forms by release of a variety of organic acids like succinic, citric, malic, fumaric, glyoxalic and gluconic acids.

Some strains of plant growth-promoting rhizobacteria can effectively stimulate the growth of plants by direct or indirect effects (Sylvia et al. 1999). Dutta at al 2010 had integrated chemical fertilizer with azotobacter and VAM for increased yield and improved quality of litchi.
Keeping these factors into consideration, an experiment was laid out to generate information, if plant growth promoting rhizobacteria inoculations can increase germination percent of kusum seeds. At the same time, effort was made to see whether integration of PGPR and chemical fertilization can increase seedling growth satisfactorily.

Material and methods

For evaluating germination, *kusum* seeds collected during July, 2014 were inoculated with different PGPRs and further, growth of seedlings obtained were evaluated through application of different levels of soil fertility. For the study, seeds of *kusum* were collected from Jhalda, Purulia, W. Bengal and were subjected to inculcation with culture of *azotobacter*, *vasicular arbascular mycorrhizae* and *phosphobacteria* as per recommendation.
Sowing of seed was done in the month of august. Data on germination percent was recorded initially at 5 and at later stages

at 15 days interval for evaluation of the effect of seed inoculation with different PGPRs. *Azotobacter* and *phosphobacterin* cultures were procured from Birsa Agriculture University, Ranchi and VAM culture was procured from Microbiology Division of Indian Institute of Agricultural Research, New Delhi.

Recommended doses of fertilizers (75-25-75 g/ plant N, P_2O_5 and K_2O equivalent to @ 38-12-36 mg/ polytube) was computed to suit for a polytube containing 600 g soil were applied at 110 days after sowing and growth parameters like plant height, number of leaves, basal diameter, tap root length, shoot and root weight etc were recorded from time to time. Soil of experimental area is characterized by organic carbon content 0.45%, soil pH 3.93, N 206.9 kg/ha, P_2O_5 29.0 kg/ha and K_2O 147.6 kg/ha. All the four factors e.g. fertilizer (F0 and F1), azotobacter (A0 and A1), VAM (V0 and V1) and *phosphobacterin* (P0 and P1) were allocated in RBD in factorial mode, replicated 6 times.

Results and Discussions

Effect of inoculation of PGPR and fertilizer application on *kusum* seed germination and seedling growth

A sharp reduction in germination percent was noticed due to inoculation of *kusum* seed with PGPRs (Table 1) like *Azotobacter*, *Phosphobacterin* and *Vasicular Arbuscular Mycorrhizae* (VAM). Inhibitory effect of *Phosphobacterin* started from 16 days onwards, while that of Azatobactor and VAM was noticed from 26 and 51 days after sowing, respectively. By the end of September, Azotobacter, Phosphobacterin and VAM registered a mean reduction in germination to the tune of 9.5, 12.7 and 7.5 percent over control.

Seedling mortality was not affected significantly due to any of the PGPRs, therefore survival percent was found uniform. However, fertilizer application reduced survival percent significantly (Table 2) at later stage i.e. in February.

Stephan *et al* 2008 concluded that inhibitory effect is due to a competition for nutrient resources between the seeds and *rhizobacteria* and not due to an oxidative stress induced by the presence and activity of PGPR. During the germination, the seeds have to produce different non-proteic compounds from proteins (*e.g.* sugars for cell walls, lipids for membranes, etc) before the photosynthetic processes begins (Mathews *et al*., 2000). Therefore, the concerned bacteria/ micro-organisms of the PGPR treated seeds might have consumed sugar/ amino acids which might have led to a decrease of the germination processes.

Effect of chemical fertilization at recommended rate and inoculation of azotobacter, phosbacterin and VAM was observed on plant growth during the month of February.

Fertilizer application at recommended rate could bring a remarkable change in mean tap root length and shoot dry weight of *kusum* seedlings, although its application has witnessed seedling mortality at initial stage (Table 3). Inoculationn of *azotobacter* proved to be indifferent to influence any of the plant growth attributes. *Phosphobacterin* proved to be the most significant factor affecting seedling growth. Shoot and root weight were affected the most; forty four and 46 percent reduction in weight was observed as compared to control. VAM affected seedling growth moderately and its effect was observed on shoot diameter, shoot dry weight and leaf dry weight. Maximum reduction was observed on leaf dry weight (31 percent).

Interaction effect of fertilizer application and seed inoculation of *Azotobacter*, *Phosphobacterin* and VAM on growth of *kusum* seedlings

Out of 11 interactions of different orders, 10 showed its influence in some form or the other. Fertilizer *vs. Phosphobacterin* and Fertilizer *vs.* VAM application interactions proved to show their influence on 4 and 6 parameters out of 10, respectively. Other interactions could show its presence on 1-3 parameters. Interaction study in majority of cases showed that interaction of factors in its lowest level of application (control) performed the best followed by condition when applied in highest levels (Fig 1 and 2). In case of shoot diameter, no fertilizer and no VAM application registered 5.6 mm thickness of shoot which was at par to that obtained under fertilizer application and VAM inoculation. Similarly, no fertilizer application and no phosphobacterin inoculation registered highest thickness of shoot (6.0 mm) and it was significantly different from that obtained under application of both the factors.

Thus, a combination of no fertilizer application and no *phosphobacterin* inoculation performed either better or similar to combination of fertilizer application and phosphobacterin inoculation. Other combinations are inferior in growth promotion. In other words, negative effect of one factor can be nullified if the other factor is applied.

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Table 1: Germination per cent of *kusum* seeds as affected by inoculation of different PGPRs

	10 DAS	15 DAS	22 DAS	25 DAS	35 DAS	50 DAS	65 DAS	80 DAS
A0	3.4	10.8	15.4	17.1	22.7	26.9	28.4	29.5
A1	2.2	7.3	10.8	12.4	15.3	17.6	19.3	20.0
CD	1.8	3.4	4.5	3.3*	3.6*	3.6*	3.7*	3.8*
P0	3.4	11.4	16.4	18.6	23.8	28.2	30.2	31.1
P1	2.2	6.7	9.9	10.8	14.3	16.3	17.4	18.4
CD	1.8	3.4*	4.5*	3.3*	3.6*	3.6*	3.7*	3.8*
V0	3.3	10.3	14.2	15.9	21.2	25.3	27.7	28.5
V1	2.3	7.7	12.0	13.5	16.9	19.2	19.9	21.0
CD	1.8	3.4	4.5	3.3	3.6	3.6*	3.7*	3.8*

*Significant at 5% level

NB: A: Azotobacter, P: Phosphobacterin, VAM: Vasicular Arbascular Mycorrhizae

Table 2: Effect of PGPR inoculation and fertilizer application on plant growth parameters after 7 months:

	Survival percent	Basal shoot diameter (cm)	Shoot length (cm)
F0	86.3	4.28	9.3
F1	80.3	3.89	9.0
	*	*	
A0	83.0	4.43	9.9
A1	83.6	3.74	8.5
P0	84.2	4.30	9.7
P1	82.4	3.88	8.7
V0	84.4	4.37	9.5
V1	82.2	3.80	8.9
CD $_{(.05)}$	2.80	0.13	0.35

*Significant at 5% level

Table 3: Effect of PGPR inoculation and fertilizer application on plant growth parameters after 9 months:

	Shoot diameter (mm)	Shoot length (cm)	Root length (cm)	Shoot wt (g)	Root wt (g)	Leaf wt (g)	Tap root length (cm)	Shoot dry wt. (g)	Leaf dry wt (g)	Root dry wt. (g)
F0	5.0	14.9	22.5	2.7	3.2	3.7	8.2	0.9	1.5	1.3
F1	5.2	15.4	23.1	2.9	4.1	3.5	14.6	1.1	1.3	1.1
							*	*		
A0	5.2	15.6	23.3	2.9	3.8	4.1	10.6	1.1	1.5	1.2
A	5.0	14.8	22.3	2.7	3.5	3.1	12.2	0.9	1.2	1.1

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P 0	5.7	16.3	24.3	3.2	4.7	4.7	12.5	1.1	1.8	1.5
P 1	4.5	14.1	21.3	2.5	2.6	2.5	10.3	0.9	0.9	0.9
	*	*		*	*	*		*	*	*
V 0	5.4	15.8	25.0	3.0	3.6	4.0	11.4	1.1	1.6	1.3
V 1	4.8	14.5	20.6	2.6	3.7	3.1	11.4	0.9	1.1	1.0
	*							*	*	
C D	0.4	1.5	4.2	0.5	1.5	1.0	3.9	0.2	0.4	0.5

*Significant at 5% level

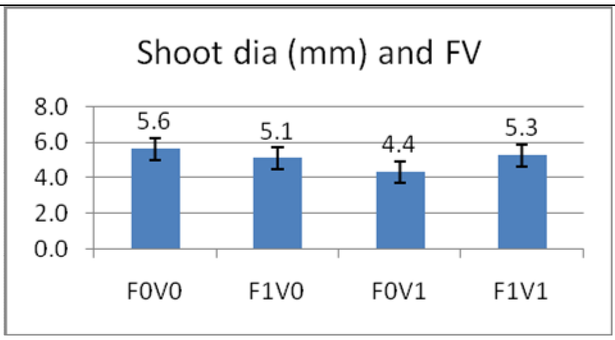

Fig 1: Interaction effect of fertilizer and VAM

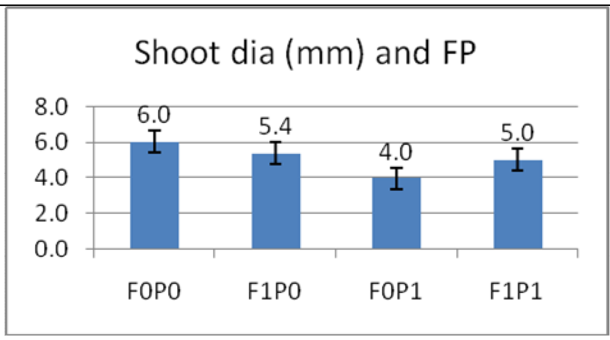

Fig 2: Interaction effect of fertilizer and *phosphobacterin*