Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(3): 819-821
Received: 07-03-2018
Accepted: 11-04-2018

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Effect of mode of nutrition on growth behavior of developing litchi (*Litchi chinensis* Sonn) in indo-Gangetic plains of Uttar Pradesh

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Abstract
The present investigation was carried on to trace mode of action of varieties, lime application and mode of nutrient supply system on growth pattern of developing litchi orchard. The variety Purvi performs better over early Bedana in all the growth parameters except spread where in the two verities behaved similarly. Lime was not observed to have marked effect on a height, spread, girth and branches of plants. But plants getting slacked lime had more no. of leaves (56 leaves/plant) against (50.34) under control, higher leaf per plant (6963 cm^2) against (6710 cm^2) under control and LAI of 1.05 against 1.01 under control. Amongst growth factors initially 100% nutrition through inorganic sources had the best expression but by the end of 24^{rth} month 50:50 nutrition in organic-inorganic form over to 100% inorganic source. The treatment having 100% organic source though FYM had the most subdued expression.

Keywords: ganga-yamuna basin, agro climate amplitude, loosing of nutrients, organic-inorganic, litchi and growth behavior

Introduction
Litchi (*Litchi chinensis* Sonn.) is cultivated in a narrow latitude band covering semi humid regions having well drained soils in Bihar, Uttar Pradesh and west Bengal. However its cultivation in calcareous belts of north Bihar is the most prominent region from yield and quality point of view. Litchi is adapted to warm subtropics with brief dry, frost free winters and long hot summer with high rainfall and humidity. Allahabad situated in the Ganga-Yamuna basin offers a climate more of less close to the optimum agro-climatic amplitude considered optimum for Litchi cultivation. In Bihar where longer cool periods before the flowering of litchi facilitates better fruiting. Comparatively higher relative humidity thereafter further helps in development of fruits (Pattern and Mc conchie, 1995; and Menzel and Simpson, 1994) [2, 3].

The growth of plants is directly correlated to nutrition they experience along with the climatic factor. As a result it is of paramount importance to find out the best nutritional combinations so as to obtain speedy development of orchards along with maintaining their potential.

Besides its attractive and specific look and color, litchi has attracted agragarian population for its potential as a commodity for export. India is exporting litchi and its various products to China, Thailand, Mauritius, UK, Malaysia, South Africa UAE and United States. It is encouraging to make a note here that most of the counties mentioned above are themselves litchi growing countries. This speaks volumes about the quality of produce and products prepared in India. The export income from litchi is increasing at a very fast rate India exported litchi worth 19 Lakhs in 2011-12 which increased to 31 lakhs in 2012-13 and to 84 lakh in 2013-14 (APEDA, 2015) [1].

The characteristics and potential of its cultivation in Ganga -Yamuna basin emphasis to carry on this experiment to optimize nutrition for a developing Litchi orchard.

Materials and Methods
The field experiment was conducted at central Research farm Department of Horticulture, Sam Hihggin bottom University of Agriculture, Technology and Sciences, Allahabad (U.P.) for two consecutive years during 2015 and 2016. The experiment was conducted in split plot design with two varieties purvi (V_1) and Early bedana (V_2) in main plot, two treatments pertaining to calcium application (No slaked lime C_1 and 2 kg slaked lime/plant-C_2) in sub-plot and three manorial schedules (100% organic sources FYM-F_1, 50% organic source + 50% inorganic sources-F_2 and 100% inorganic sources F_3) in sub-sub plots. Organic manure FYM and slacked limes were applied only once during July while inorganic fertilizers urea for nitrogen

and murate of potash for K_2O were applied twice i.e. in July and March in equal proportion. Phosphate was single super phosphate as applied only once in July. Thus, 12 treatment combinations were tested in three replications. Three plants were planted in each sub-sub plot thus making a total of 108 plants.

The experimental plot was sandy loam in texture with available N, P_2O_5 and K_2O in medium range. Organic carbon was 0.54% and soil reaction in neutral range (PH-7.6).

Results and Discussion

Plant height recorded at the 3rd, 12th and 24th months after planting was affected significantly due to varieties. Organic-inorganic combinations too were significant except on the 3rd month after planting when the differences were not marked. Slacked lime did not cause plant height to vary significantly. Right from its easily planting stage Purvi was taller than early Bedana which continued till the end of experiment (24th month) on the 3rd month Purvi was 39.5cm as against 30cm height of early Bedana. After 12 months and 24th months these were 70.50 cm and 62.0cm; 125.0 cm and 105.83 cm. The plant spread (North-South and east-west) were not affected significantly due to varieties and application of slacked lime. However, nutrition could cause significant variation giving entire nutrition through organic source (FYM) had the least spread. Whereas, application of organo-inorganic source in 50:50 ratio (F_2) had significantly the maximum N-S Spread but it was at par with 100% inorganic source (F_3) as regard E-w spread. While N-S spread under F_2 was 53.50 cm, it was 49.50cm under F_3.

Girth of stem was least affected in early stages but later on (12th month onward) purvi (V_1) was thicker than early Bedana (V_2) on the 24th month. Purvi was 12.67cm thick as against 10.9 cm. under early Bedana. Slacked lime did not cause girth of stem to vary significantly. Amongst nutrition sources F_2 (50:50 organo-inorganic sources) having girth of 12.35cm was significantly thicker than F_3 (100% inorganic) having a girth of 11.99 cm which in there was thicker than 100 organic source FYM (F_2).

Number of branches too was not affected significantly due to slaked lime application. The variety Purvi had significantly more branches (9.20) than Early Bedana (7.80) on the 12th month F_3 (100% inorganic) had significantly higher number of branches (5.68) than F_2 (50:50 organic-inorganic) having 5.25 branches. The treatment F_1 (100% organic) had significantly the least (4.93) branches. However, at 24 months after planting the table reversed somewhat as F_2 recorded significantly the highest branches (8.80) as against 8.53 under F_3 and F_1` being the least (8.15).

Number of leaves/plant was not affected significantly due to varieties, but both slacked lime (C) and sources of nutrition were significant at the 12th and 24th months, plants getting slacked lime had significantly higher number of leaves than those raised without lime on the 24th month C_2 had 56 leaves/plant as against 50.34 under C_1 (control). Both F_3 (100% inorganic) and F_2 (50:50 organic inorganic) were statistically a lime but superior to F_1 (100% organic) in regard to number of branches while F_1 (100% organic) had significantly the least. Quite contrary to this the leaf area was affected significantly by all the three factors except slacked lime at the 3rd and 6th month after planting. Variety Purvi recorded 7124 cm^2 leaf area/plant against 6548 cm^2 under early bedana on the 24th month planting. In the same observation plants getting lime had 6963 cm^2 leaf area against 6710cm^2 under control on the 12th month whereas F_3 (100% inorganic) had significantly the highest leaf area followed by F_2 (50:50 organo-inorganic combination) and F_1 (100% organic) in descending order. But by the end of 2nd year F_2 (17404 cm^2) surpassed F_3 (16866 cm^2) and F_1 (6629cm^2) had still the least leaf area. Leaf area index was also affected by all the three factors whereas Purvi (1.06) over took Early Bedana (1.01) slacked lime (1.05) scored over control (1.01). Amongst nutrient sources at the 17th month F_3 (0.94) was superior to F_2 (0.91) but by the 24th month F_2 (1.05) was statistically equal to F_3 (1.04).

Table 1(a): Growth of plants as affected by varieties, calcium and sources of nutrients

Treatments	Plant Height (cm)			Plant spread (cm) North-South			Plant spread (cm) East-West			Girth of stem (cm)		
	3rd months	12th months	24th months	3rd months	12th months	24th months	3rd months	12th months	24th months	3rd months	12th months	24th months
Main plot (Variety)												
V_1-Purabi	39.50	70.50	125.00	39.00	34.17	50.50	17.67	27.50	42.00	7.50	9.75	12.67
V_2-Early Bedana	30.00	62.00	105.83	39.67	33.17	49.83	17.17	28.67	43.83	7.28	9.16	10.96
SE M ±	0.03	0.42	0.91	0.16	0.31	0.36	0.20	0.36	0.56	0.00	0.06	0.10
CD at 5%	0.14	1.82	3.95	NS	NS	NS	NS	NS	NS	NS	0.27	0.43
Sub-plot (Calcium)												
C_1-No slacked lime	35.00	66.00	114.00	19.25	33.00	50.00	17.00	27.34	42.84	7.40	9.41	12.41
C_2-2 kg slacked lime per plant per yr.	34.50	67.00	117.00	19.75	34.00	51.67	18.36	28.37	43.00	7.39	10.01	12.23
SE m ±	0.22	0.44	1.09	0.18	0.49	0.81	0.33	0.29	0.35	0.00	0.06	0.12
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub-sub plot (Fertilizers)												
F_1-100% organic Source (FYM)	35.00	62.50	111.50	19.75	31.50	47.50	17.25	25.00	38.75	7.41	8.96	11.11
F_2-50% Organic + 50% Inorganic	34.75	66.50	115.50	21.00	35.25	53.50	18.00	29.50	42.25	7.35	9.99	12.35
F_3-100% Inorganic	34.50	70.25	119.00	18.25	34.25	49.50	17.00	29.75	44.75	7.41	9.81	11.99
SE m ±	0.80	1.31	2.39	0.45	0.71	1.28	0.52	0.76	1.22	0.17	0.19	0.26
CD at 5%	NS	2.79	5.06	0.95	1.52	2.71	NS	1.62	2.59	NS	0.39	0.55

Table 1(b): Growth of plants as affected by varieties, calcium and sources of nutrients

Treatments	No. of branches			No. of leaves per plant			Leave area (cm^2)			Leaf Area index (LAI)		
	3rd months	12th months	24th months	3rd months	12th months	24th months	3rd months	12th months	24th months	3rd months	12th months	24th months
Main plot (Variety)												
V_1-Purabi	3.20	5.72	9.20	9.50	45.83	52.00	2530	3813	7124	0.68	0.93	1.06
V_2-Early Bedana	3.00	4.85	7.80	9.15	46.50	53.83	2251	3490	6548	0.70	0.90	1.02
SE M ±	0.05	0.02	0.09	0.17	0.29	0.36	1.65	33.14	69.47	0.01	0.01	0.01
CD at 5%	NS	0.08	0.38	NS	NS	NS	7.08	142.57	298.89	NS	0.02	0.02
Sub-plot (Calcium)												
C_1-No slacked lime	3.12	5.25	8.04	9.25	43.17	50.34	2345	3578	6710	0.65	0.88	1.01
C_2-2 kg slacked lime per plant per yr.	3.9	5.32	8.49	9.40	49.17	56.00	2432	3726	6963	0.64	0.92	1.05
SE m ±	0.01	0.07	0.08	0.09	0.28	0.41	40.92	32.53	78.69	0.00	0.01	0.00
CD at 5%	NS	NS	NS	NS	0.78	1.15	NS	90.3	218.28	NS	0.03	0.02
Sub-sub plot (Fertilizers)												
F_1-100% organic Source (FYM)	3.05	4.93	8.15	9.35	42.00	48.75	2174	3419	6629	0.67	0.87	0.99
F_2-50% Organic + 50% Inorganic	3.15	5.25	8.80	9.53	44.50	55.25	2447	3671	7014	0.70	0.91	1.05
F_3-100% Inorganic	3.10	5.68	8.55	9.10	44.00	54.75	2551	3865	6866	0.71	0.94	1.04
SE m ±	0.07	0.13	0.23	0.24	1.03	1.28	62.02	94.31	141.02	0.07	0.01	0.02
CD at 5%	NS	0.27	0.49	0.50	2.19	2.72	131.49	199.93	304.17	NS	0.03	0.05

The quick availability of nutrients like NPK through inorganic sources are expected to give an early lead in growth and development of plants whereas, organic sources took adequate time to mineralize and those is also possibility of immobilization of nutrients causing less availability of nutrients to the plants (Sahai, 2015) [4]. However, the locked up nutrients in immobilization may be available again in later stage of growth accelerating growth there after (Das, 2015) [5]. Besides the microorganism responsible for mineralization has to accelerate their population to hasten mineralization for which they utilize adequate amount of nutrients, also referred too as locking of nutrients (Buckman and Bredy, 1984) [6].

The growth of a variety is primarily a reflection of its genetic potential which may also be modified to some extent by management level (Chauhan, 2001 and Singh *et al*. 2012) [7, 8]. Calcium is observed to increase growth in leaves (Reddy and Reddy, 2006 and Yawalkar *et al*. 2003) [9, 10].

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