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Studies on Nutritional Requirement of Young Arabica Coffee under Shaded Condition

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Abstract

Field experiment was conducted in young coffee plantation at Central Coffee Research Institute, Karnataka to study the effect of different levels of fertilizers, sources of phosphorus with and without microbial inoculants on arabica coffee (*Coffea arabica cv. Chandragiri*). There were 12 treatment combinations replicated thrice with three levels of fertilizers, two sources of phosphorus and with and without microbial inoculants. The experiment results revealed that combined application of phosphorus (20:20:20 g/plant/year) with microbial inoculants recorded significantly highest growth parameters such as stem girth (27.53 mm/plant), bush spread (101.85 cm/plant), number of primaries (13.63), length of longest primary (72.29 cm/plant) and number of nodes on longest primary (16.42) at all the growth intervals compared to other levels of fertilizers. Among the sources of phosphorus, application of 50 % rock phosphate along with 50 % single super phosphate registered significantly highest growth parameters over application of only 100 % rock phosphate and treatment inoculated with microbial inoculants recorded significantly higher growth, dry matter accumulation and nutrient uptake over un-inoculated treatments.

Keywords

Arabica coffee; Levels of fertilizers; Nutrients management; Bio-inoculants; Growth parameters

Introduction

Coffee (*Coffea* sps. Family - Rubiaceae) is the important commercial crop grown worldwide in about 50 countries. In terms of trade value, it is next only to the petroleum products with a total industry turnover of nearly US$ 70 million. Although the genus *Coffea* has more than 25 species, only two species viz., *Coffea arabical* L. popularly known as Arabica coffee and *C. canephora* Pierre ex Froehner known as Robusta coffee are cultivated commercially. One of the major problems that confront the coffee planter is the difficulty in establishing young seedlings in the main field after transplanting. Obatolu [1] reported that factors like slow growth of seedlings, long dry spells after field transplanting and transplantation shock affect the establishment of young seedlings in the field. Under these circumstances, the important consideration is to boost the growth and development of young coffee plants in the main field, so as to achieve establishment of healthy and productive plantation that lasts for couple of generations.

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In order to achieve healthy growth of young coffee plants during establishment stage, special attention should be paid to balanced nutrition [2,3]. Although a great deal of research has been undertaken into the nutrition requirement of grownup coffee in many countries, but only few studies exist on young coffee. In India also, detailed studies are not available on the nutritional requirement of young coffee. With this background the present investigation on "Response of young coffees to different levels and sources of fertilizers with or without microbial inoculants " was under taken at coffee research station to arrive at optimum level and ideal sources of major nutrients for successful establishment of young coffee seedlings in the field.

Material and Methods

Field experiment was carried out at Central Coffee Research Institute during the year 2012 and 2013. The soil of the experimental site was sandy loam with pH 5.9. This trial was conducted in young Arabica coffee cv Chandragiri plantation (two years after transplantation). The experiment was laid out in Factorial Randomized Complete Block Design with 12 treatments combinations and replicated with three times involving three levels of fertilizers F_1- 10:20:10 NPK g/plant/year, F_2- 20:10:20 NPK g/plant/year (Control) and F_3- 20:20:20 NPK g/plant/year, two phosphorus source P_1: 100% water insoluble fertilizers -RP- Control) and P_2:50:50 (Water insoluble - RP+ water soluble fertilizers- SSP) and with and without microbial inoculants. Trail was initiated at 24 MAIT- Months after imposition treatments The fertilizers in form of urea, rock phosphate, single super phosphate and muriate of potash were applied in two splits (May and September) followed by microbial application after one month after application of fertilizers. During the study period (2012 and 2013), the rainfall received was 3151 mm and 2627 mm respectively. The mean maximum and minimum temperature recorded during 2012 was 32.5 °C and 13.8 °C and 33.5 °C and 16.5 °C during the year 2013 respectively. All the necessary cultural operations were carried as per package of practices [4] and the periodic observations were recorded on growth, dry matter and nutrient uptake and analyzed with appropriate statistical design [5] and discussed in the following results and discussion chapter.

Results and Discussion

There was significant difference with respect to growth parameters in young coffee due to different levels of fertilizers. Significant higher growth parameters was recorded for stem girth (27.53 mm/plant), bush spread (101.85 cm/plant) number of primaries (13.63) length of longest primary (72.29 cm/plant) and number of nodes on longest primary (16.42) at end of two years after transplanting to main field for F_3 level of fertilizer, While lowest growth rate was recorded under F_1 level of fertilizer during both the years (Tables 1 and 2). The same trend was followed with respect to dry matter accumulation and nutrient uptake. Similar results were reported by Nazareno et al. [6], Cai et al. [7] and Rajbir et al [8].

Significant increase in growth parameters, dry weight accumulation and nutrient uptake was recorded with combined application of phosphorus (50% Rock phosphate + 50% Single super phosphate) compared to application of only 100% source of rock phosphate. The reason for good performance of plant growth with 50 % Rock

Table 1: Growth parameters at 24 MAIT as influenced by different levels of fertilizers, sources of phosphorus with and without microbial inoculants on *Coffea arabica* Cv. Chandragiri.

Treatment	Stem girth (mm)	Bush Spread (cm /plant)	Length of longest primaries (cm)	No. of nodes on longest primaries
Fertilizer levels (F)				
F_1: 10:20:10 NPK g/plant/year	25.45	91.74	64.03	12.58
F_2: 20:10:20 NPK g/plant/year	24.98	96.40	69.26	15.50
F_3: 20:20:20 NPK g/plant/year	27.53	101.85	72.29	16.42
S.Em.±	0.71	2.44	1.37	0.23
C.D. (p=0.05)	2.08	7.16	4.02	0.69
Phosphorus Sources (P)				
P_1: 100% Rock phosphate (RP)	24.97	92.77	67.83	14.44
P_2: 50 % RP + 50 %SSP	27.00	100.55	69.22	15.22
S.Em.±	0.58	1.99	1.12	0.19
C.D. (p=0.05)	1.70	5.84	NS	0.57
Microbial inoculants (M)				
M_1: With microbial inoculants	27.10	100.73	69.88	15.22
M_2: Without microbial inoculants	24.87	92.60	67.17	14.44
S.Em.±	0.58	1.99	1.12	0.19
C.D. (p=0.05)	1.70	5.84	NS	0.57
Interaction (F X P)				
S.Em.±	1.00	3.45	1.94	0.33
C.D. (p=0.05)	NS	NS	NS	NS
Interaction (F X M)				
S.Em.±	1.00	3.45	1.94	0.33
C.D. (p=0.05)	NS	NS	NS	NS
Interaction (P X M)				
S.Em.±	0.82	2.82	1.58	0.27
C.D. (p=0.05)	NS	NS	NS	NS
Interactions (F X P X M)				
S.Em.±	1.42	4.88	2.74	0.47
C.D. (p=0.05)	NS	NS	NS	NS

Note: MAIT- Months after imposition treatments

Table 2: Total dry matter accumulation and nutrient uptake at 24 MAIT as influenced by different levels of fertilizers, sources of phosphorus with and without microbial inoculants on *Coffea arabica* Cv. Chandragiri.

Treatments	Total dry weight (g/plant)	Total nutrient uptake (g/plant)		
Fertilizer levels		**Nitrogen**	**Phosphorus**	**Potassium**
F_1: 10:20:10 NPK g/plant/year	290.99	7.24	0.42	2.95
F_2: 20:10:20 NPK g/plant/year	407.51	12.60	0.69	5.84
F_3: 20:20:20 NPK g/plant/year	530.96	23.04	1.38	8.40
S.Em.±	1.89	0.27	0.01	0.08
C.D. (p=0.05)	5.54	0.80	0.03	0.24
Phosphorus Sources (P)				
P_1: 100% Rock phosphate (RP)	369.69	11.74	0.63	5.06
P_2: 50 % RP + 50 %SSP	449.95	16.84	1.03	6.40
S.Em.±	1.54	0.22	0.01	0.07
C.D. (p=0.05)	4.52	0.65	0.03	0.20
Microbial inoculants (M)				
M_1: With microbial inoculants	428.93	17.03	0.90	6.25
M_2: Without microbial inoculants	390.71	11.55	0.76	5.21
S.Em.±	1.54	0.22	0.01	0.07
C.D. (p=0.05)	4.52	0.65	0.03	0.20
Interaction (F X P)				
F_1P_1	278.15	6.06	0.38	2.63
F_1P_2	303.83	8.42	0.46	3.27
F_2P_1	375.84	10.19	0.52	5.26
F_2P_2	439.18	15.00	0.87	6.43
F_3P_1	455.08	18.97	0.99	7.29

F_3P_2	606.85	27.10	1.76	9.51
S.Em.±	2.67	0.39	0.02	0.12
C.D. (p=0.05)	7.83	1.13	0.05	0.34
Interaction (F X M)				
F_1M_1	302.14	7.79	0.47	3.33
F_1M_2	279.84	6.69	0.37	2.56
F_2M_1	413.64	13.47	0.73	6.17
F_2M_2	401.38	11.72	0.65	5.52
F_3M_1	571.01	29.82	1.50	9.26
F_3M_2	490.91	16.25	1.25	7.54
S.Em.±	2.67	0.39	0.02	0.12
C.D. (p=0.05)	7.83	1.13	0.05	0.34
Interaction (PX M)				
M_1P_1	393.41	14.05	0.72	5.58
M_1P_2	464.45	20.01	1.08	6.92
M_2P_1	345.97	9.43	0.55	4.53
M_2P_2	435.45	13.68	0.97	5.88
S.Em.±	2.18	0.32	0.01	0.09
C.D. (p=0.05)	6.40	0.92	0.04	NS
Interaction (FXPX M)				
$F_1P_1M_1$	299.07	6.68	0.44	3.20
$F_1P_1M_2$	257.22	5.43	0.32	2.05
$F_1P_2M_1$	305.21	8.90	0.50	3.46
$F_1P_2M_2$	302.45	7.94	0.41	3.07
$F_2P_1M_1$	389.63	10.67	0.61	5.73
$F_2P_1M_2$	362.05	9.71	0.44	4.78
$F_2P_2M_1$	437.64	16.28	0.86	6.60
$F_2P_2M_2$	440.71	13.73	0.87	6.25
$F_3P_1M_1$	491.52	24.79	1.11	7.81
$F_3P_1M_2$	418.64	13.15	0.88	6.77
$F_3P_2M_1$	650.51	34.85	1.89	10.71
$F_3P_2M_2$	563.18	19.35	1.62	8.32
S.Em.±	3.78	0.55	0.02	0.16
C.D. (p=0.05)	11.08	1.60	0.07	0.48

Note: MAIT- Months after imposition treatments

phosphate and 50% SSP could be attributed to the water soluble part of phosphorus supplied through single super phosphate, which can be readily taken by plant. This clearly implies that during early stage of coffee plant growth, combined application of single super phosphate (SSP) and Rock phosphate (RP) helps the plant to put forth good growth compared to application of only rock phosphate which is recommended practice in coffee cultivation [3,8,9].

Inoculation with microbial inoculants increased the dry matter accumulation (428.93 g/plant) significantly over un-inoculated (390.71 g/plant). This may be due to increased availability of nutrients, consequently increase in metabolic activity and photosynthetic ability of plant which could be accessed through increase in leaf area (7174.51 cm^2/ plant) leaf are index, leaf area duration (27.09 at 21-24 MAIT interval) and growth rates than the un-inoculated (6741.89 cm^2 /plant leaf area) and leaf area duration (25.45 at 21-24 MAIT interval).

The interaction effect of different levels of fertilizers, source of phosphorus with and without microbial inoculants were found significant for dry matter accumulation and nutrient uptake. The first pre requisite for good growth of the plant is a high production of total dry matter, as it signifies photosynthetic ability of the crop and also indicates other synthetic processes during the developmental sequences [7,10,11,12,13] . In the present study, higher total dry matter was recorded with F_3 level of fertilizer 20:20:20 NPK g/plant/year, P_2 source of phosphorus (50 % Rock phosphate with 50 % SSP) combined with microbial inoculants (650.51 g/plant) than the recommended level of fertilizer 20:10:20 NPK g/plant/year, P_1 Source of fertilizer (100% Rock phosphate) without microbial inoculants (362.05 g/plant). The least dry matter was registered by the F_1 level of fertilizer, 10:20:10 NPK g/plant/year application of phosphorus through rock phosphate only and without microbial inoculants.

From the foregoing discussion, it could be inferred that among the fertilizer levels, F_3 level of fertilizer (20:20:20 NPK g/plant/year) was found superior for growth and growth attributes. The combined application of phosphorus and inoculation with microbial inoculants was found to be significant in improving the dry matter accumulation and nutrient uptake of plants resulting in production of vigorous growth and development of young coffees at pre bearing stage.

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