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Effect of Native AMF inoculation on Nutrient Composition, Uptake and Quality Attributes in Cassava

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Abstract

Results of the potted cassava experiment conducted during the crop season of 2018 and 2019 to determine the influence of native AMF inoculation in cassava revealed that inoculation of *Glomus fasciculatum* (AMF culture No 3) with P nutrition at 100 per cent combined with application of N and K at recommended dose had remarkably increased the concentration of N, P, K, content in leaf P and K content in tuber. However, inoculation of *G. fasciculatum* (AMF culture No 3) had shown higher values for nutrient concentration, and it was statistically on par with inoculation of *G. fasciculatum* with P nutrition at 50 per cent and N and K at recommended dose. Uptake of NPK in leaf, stem and tuber was studied for this experiment which showed that inoculation of *G. fasciculatum* (AMF culture No 3) had higher values. Hence *G. fasciculatum* (AMF culture No 3) can be recommended for inoculation in cassava and the application of P fertilizer can be reduced to 50 per cent of the recommended dose for realizing maximum tuber yield and quality.

Key words: AMF inoculation, P nutrition, nutrient uptake, root colonisation

Introduction

Cassava is considered as a subsistence crop grown traditionally by poor and marginal farmers, but is becoming increasingly important as a commercial crop in most of the growing areas across the world (Byju and Suja, 2020). Globally cassava is cultivated in area of 20.73m.ha with a total production of 276.72 m.t with an average tuber yield of 13.35 t ha^{-1}. In Kerala, it is cultivated as secondary staple food with a total area of 62,070 ha and with a total production of 2.59 m.t. The average tuber yield is reported to be 41.77 t ha^{-1} (Farm Guide, 2020). The major constrains for increasing the productivity of cassava is the low soil fertility and poor soil health management. By overcoming the soil fertility constraints, it is possible to increase cassava yield by 22% in Asia and 21% globally (Hentry and Gottret, 1996). Due to high productivity of tuber crops compared to field crops, the nutrient uptake is very high implying to the substantial quantity of nutrient removal from the soil. It has been proved already that applying chemical fertilizer alone nor organic sources exclusively achieve the production sustainability of soil and crop. However integrated use of chemical fertiliser with organic manures and biofertilisers can restore and sustain soil fertility (Susan John *et al*., 2019).

Since cassava has got a very coarse and poorly branched root system, it is inefficient in exploring large volume of surrounding soil for nutrient extraction. While non-mycorrhizal roots absorb P mainly through the root hairs, which may extend 1-2 mm from the root surface, the mycorrhizal infected roots absorb P mainly through the external hyphae, which may extend several centimeters into the soil. As such, these roots can explore a much larger volume of soil from which P and other low mobility nutrients can be absorbed. (Howler1, 1982). Cassava is highly mycotrophic and the beneficial effect of mycorrhizae is of much importance in plants having coarse and poorly branched root system, since the external mycelia can extend up to 8 cm away from the root region (Potty, 1990). The present study was initiated to determine the effect of AMF inoculation in cassava at different levels of P nutrition on growth and development and thereby identifying the most efficient strain of AMF for enhancing growth and economizing the use of P fertilizer in cassava.

Materials and Methods

The present study was undertaken at Krishi Vigyan Kendra (KVK), Pathanamthitta (PTA), Kerala during the crop season of 2018 (April to September) and 2019 (April to September) as pot culture experiment in Completely Randomised Design (CRD) with 12 treatments and 10 replications. The treatment schedule consists of

T_1. Non-inoculation of Arbuscular Mycorrhizal Fungi with no P nutrition and N and K application at RD.

T_2. Inoculation of Arbuscular Mycorrhizal Fungi culture number 1 with no P nutrition and N and K application at RD.

T_3. Inoculation of Arbuscular Mycorrhizal Fungi culture number 2 with no P nutrition and N and K application at RD.

T_4. Inoculation of Arbuscular Mycorrhizal Fungi culture number 3 with no P nutrition and N and K application at RD.

T_5. Non-inoculation of Arbuscular Mycorrhizal Fungi with P nutrition at 50 per cent and N and K application at RD.

T_6. Inoculation of Arbuscular Mycorrhizal Fungi culture number 1 with P nutrition at 50 per cent and N and K application at RD.

T_7. Inoculation of Arbuscular Mycorrhizal Fungi culture number 2 with P nutrition at 50 per cent and N and K application at RD.

T_8. Inoculation of Arbuscular Mycorrhizal Fungi culture number 3 with P nutrition at 50 per cent and N and K application at RD.

T_9. Non-inoculation of Arbuscular Mycorrhizal Fungi with P nutrition at 100 per cent and N and K application at RD.

T_{10}. Inoculation of Arbuscular Mycorrhizal Fungi culture number 1 with P nutrition at 100 per cent and N and K application at RD.

T_{11}. Inoculation of Arbuscular Mycorrhizal Fungi culture number 2 with P nutrition at 100 per cent and N and K application at RD.

T_{12}. Inoculation of Arbuscular Mycorrhizal Fungi culture number 3 with P nutrition at 100 per cent and N and K application at RD.

The RD of cassava was taken as 100 kg N, 50 kg P_2O_5 and 100 kg K_2O, Farm Yard Manure (FYM) @ 12.5t ha^{-1}. Sterilised top soil collected from the farm at a depth of 30cm was used to fill the polythene cover with a size of 100X60 cm. The soil was laterite with a pH 5.6 and available P at 5.34ppm. 100 g of inoculum mixed soil containing approximately 400 spores of *Glomus mossae* isolated from alluvial soils of Pullupara, Pathanamthitta (AMF culture No 1), *G. fasciculatum* isolated from laterite soils of Vallikode, Pathanamthitta (AMF culture No 2), and *G. fasciculatum* isolated from laterite soils of Pullad, Pathanamthitta (AMF culture No3), were used for inoculation with P nutrition at zero, 50 or 100 percent along with N and K application at recommended dose (RD). The cassava, variety Vellayani Hraswa was planted with two nodes below the soil and raised as per Package of Practices Recommendation of Kerala Agricultural University (KAU) (2016) except the fertilizer recommendation and the crop was harvested at 180 DAP.

Destructive sampling was made for estimating NPK content of leaf, stem and tubers. The N content was determined by modified microjeldhal method, total P by Vanodomolydo phosphoric yellow colour method K by Flame photometric method. The uptake of NPK was calculated by multiplying the NP and K content of respective plant parts with dry weight of leaf, stem and tubers and expressed in kg ha^{-1}.

The chlorophyll content in leaf at harvest was estimated according to Arnon's formula (Arnon, 1949). AMF colonisation was determined at harvest (180 DAP) (Phillips and Haymann) (1970) and expressed in percentage. Total starches present in the tuber at harvest were estimated as per the Rapid titrimetric method standardized by Moorthy and Padmaja (2002) and it is expressed in percentage.

Results and Discussion

The concentration of N, P and K in leaf, P and K content in tuber was significantly influenced by the inoculation of *G. fasciculatum* (AMF culture No 3) with highest value of N, P and K application at RD (T12) at monthly interval during both years of study (Table 1 and 3). However, P content in leaf was statistically at par with inoculation of *G. fasciculatum* (AMF culture No 3) with P nutrition at 50 percent and N and K application at RD (T8). AMF and mineral nutrition with P had not significantly influenced N, P and K content in stem (Table 2). The uptake study result revealed that total P and K uptake was highest in treatment with *G. fasciculatum* (AMF culture No 3) with NPK application at RD (T12) and it was statistically on par with inoculation of *G. fasciculatum* (AMF culture No 3) with P nutrition at 50 per cent and N and K application at RD (T8) (Table 4 and Fig 1). The data on tuber yield at harvest revealed that AMF inoculation of culture No 3 with P nutrition at 50 per cent integrated with NK application at RD (T8) has given the highest yield followed by AMF No 3 with mineral nutrition of NPK at RD (T12) and both were significant.

Table 1. Effect of AMF and mineral nutrition on N, P, K content in leaf of cassava

Treatments	N %	P %	K %
T1	4.23	0.39	2.14
T2	4.34	0.43	2.49
T3	4.34	0.46	2.59
T4	4.56	0.48	2.79
T5	4.30	0.42	2.35
T6	4.47	0.46	2.70
T7	4.53	0.47	2.60
T8	4.75	0.50	2.88
T9	4.39	0.42	2.45
T10	4.55	0.47	2.81
T11	4.68	0.47	2.83
T12	4.82	0.50	2.98
CD (5%)	0.049	0.015	0.065

Table 2. Effect of AMF and mineral nutrition on N, P, K content in stem of cassava

Treatments	N %	P %	K %
T1	0.91	0.31	0.91
T2	1.00	0.31	1.00
T3	0.91	0.31	0.91
T4	1.10	0.34	1.10
T5	0.94	0.29	0.94
T6	1.04	0.33	1.04
T7	1.07	0.35	1.07
T8	1.13	0.38	1.13
T9	0.97	0.31	0.97
T10	1.05	0.35	1.05
T11	1.07	0.36	1.07
T12	1.12	0.38	1.12
CD (5%)	NS	NS	NS

Table 3. Effect of AMF and mineral nutrition on N, P, K content in tuber of cassava

Treatments	N %	P %	K %
T1	0.67	0.26	0.26
T2	0.73	0.27	0.27
T3	0.75	0.28	0.29
T4	0.79	0.29	0.31
T5	0.71	0.26	0.25
T6	0.73	0.28	0.29
T7	0.80	0.29	0.32
T8	0.85	0.32	0.34
T9	0.76	0.28	0.29
T10	0.83	0.31	0.33
T11	0.85	0.3	0.33
T12	0.87	0.31	0.34
CD (5%)	NS	0.01	0.009

Table 4. Effect of AMF and mineral nutrition on total N, P, K uptake and yield in cassava

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Mean yield (t ha^{-1})
T1	97.93	19.15	19.15	19.02
T2	106.27	20.63	20.63	23.05
T3	108.49	21.51	21.51	23.76
T4	118.80	23.36	23.36	28.64
T5	102.93	19.53	19.53	21.20
T6	110.97	22.04	22.04	24.60
T7	115.73	23.27	23.27	24.39
T8	125.70	25.77	25.77	33.56
T9	107.97	20.89	20.89	21.08
T10	117.10	23.94	23.94	24.27
T11	120.96	22.80	22.80	26.55
T12	126.91	26.22	26.22	32.99
CD (5%)	NS	6.5	1.44	3.72

Quality aspects in cassava like chlorophyll content in leaf at harvest were maximum in T12 followed by T8, T7, T4, T5, T6 and T10 treatments were significant. Starch of tubers at harvest was observed maximum in T11 followed by T12, T10, T8, T7 and T6 were significant. (Table 5).

Table 5. Effect of AMF and mineral nutrition on chlorophyll content in leaves and starch content in tubers at harvest in cassava

Treatments	Chlorophyll (mg g^{-1})	Starch%
T1	2.68	27.15
T2	2.69	27.37
T3	2.74	27.42
T4	2.77	27.5
T5	2.75	27.45
T6	2.75	27.55
T7	2.78	27.62
T8	2.79	27.67
T9	2.74	27.37
T10	2.74	27.8
T11	2.77	27.88
T12	2.79	27.85
CD (5%)	0.052	0.331

Cassava responds to mycorrhizal inoculation in low nutrient soils. The symbiotic AMF association can lead to increase the nutrient content of cassava plants and enhance absorption of nutrients of low mobility in soil solution such as P, Zn and Cu (Howeler,1987).

The host plants with the mycorrhizal association secrete many root exudates into the mycorhizospore and it serves as source of energy and stimulate the microbial activity. The root exudate consists of amino acids, organic acids, nucleic acid derivatives, growth regulators and vitamins. The AMF association also enhances the mineralization process of organic matters (Smith *et al*., 2011).

The plant acquired carbon is treated for various mycorrhizal benefits. The fungal mycelia that extend from the root surface into the soil matrix captures nutrients from the soil solution. The AMF hyphae colonise the root cortex and form highly branched structure inside the cells called arbuscules which acts as a functional site of nutrient exchange. The high hyphal growth and high branching nature increases the surface area with larger diameter which enables the mycorrhizal for better nutrient acquisition (Rai, 2006 and Balestrin et al., 2015).

All the above factors might have contributed for the increased chlorophyll content, nutrient concentration, major, secondary and micronutrients in leaf and uptake of major nutrients by leaf, stem, tuber in *G. fasciculatum* (AMF culture No 3) soils with P nutrition 50 per cent integrated with application of N and K at RD to record higher values for the above parameters.

It has been concluded from the study that inoculation of *G. fasciculatum* (AMF culture No 3) isolated from lateral soils of Pullad was found to be superior than of *G. mossae* isolated from the alluvial soils of Pullupara (AMF culture No 1) or *G. fasciculatum* isolated from the alluvial soils of Vallikode (AMF culture No 2) and had influenced the growth, physiology and microbial activities of the crop favoring positive effects on yield. This AMF can be recommended and included in as biofertiliser in the integrated nutrient management of cassava and the use of P fertilizer can be economized to half of the RD.

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