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Influence of Organic Manures and Biofertilizers on Rhizome Quality of Arrowroot Intercropped in Coconut

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Abstract

West Indian arrowroot (*Maranta arundinacea* L.) is an under-exploited tuber crop which is valued as a food stuff as well as source of starch. The starch is used for the preparation of various bakery products, as a base for face powder, in the preparation of barium meals and as a base for tablets, where rapid disintegration is desirable. The starch possesses demulscent and anti-diarrhoeal properties and is used in the treatment of intestinal disorders, which adds medicinal value to the crop. Presently organic farming assumes special significance due to environmental concern and food safety issues. There is dearth of information on the effect of organic management on yield and quality in arrowroot. Hence field experiments were conducted during 2007-2009 in the identified panchayats in the Western Ghat region of Thiruvananthapuram, Kerala, India, to derive an organic nutrient package for sustained yield of arrowroot. As part of the investigation, the effect of organic manures, at various levels with and without biofertilizers, on rhizome quality of arrowroot intercropped in coconut was studied in randomized block design at five locations, with three replications at each location. The results indicated that the quality characters of rhizomes, dry matter, starch, crude protein and crude fibre contents improved during both the years due to application of even 10 t ha^{-1} of farmyard manure. The study indicated the sufficiency of 15 t ha^{-1} of farmyard manure along with biofertilzers (*Azospirillum* and phosphobacteria) for realizing higher rhizome yield and improved rhizome quality of arrowroot intercropped in coconut.

Key words: West Indian arrowroot, organic manures, biofertilizers, rhizome yield, rhizome quality

Introduction

West Indian arrowroot (*Maranta arundinacea* L.) is an under-exploited tuber crop, the rhizomes of which contain 25-30% starch (CSIR, 1962), which is valued as a food stuff as well as source of starch. The starch is used for the preparation of bakery products, as a base for face powder, in the preparation of barium meals and as base for tablets, where rapid disintergration is desirable (CTCRI, 1996). The starch possesses demulscent and anti-diarrhoeal properties and is used in the treatment of intestinal disorders, which adds medicinal value to the crop. There is great demand for arrowroot starch not only in the domestic market but also for export to Gulf countries mainly as a food for infants and invalids. Earlier studies indicated that organic nutrient management improved yield and quality in elephant foot yam and yams (Suja et al., 2010; 2012a; 2012b; Suja, 2013). However, there is lack of information on the effect of organic management on rhizome yield and quality of arrowroot. Hence an investigation was undertaken in the Western Ghat region of Thiruvananthapuram district to derive an organic nutrient package for arrowroot. As part of the investigation, the effect of organic manures and biofertilizers on rhizome quality of arrowroot was also studied.

Materials and Methods

Field experiments were conducted during 2007-2008 and 2008-2009 in the identified panchayats, viz. Parassala, Pallichal, Kattakkada, Poovachal and Pullempara in the Western Ghat region of Thiruvananthapuram, Kerala, India. Arrowroot was intercropped in the inter spaces of middle aged (35-40 years) coconut palms var. West Coast Tall under 60-65% shade. Hence seven treatments as detailed below were applied at each location in randomized block design, with three replications in each location.

T_1: FYM @ 10 t ha^{-1}

T_2: FYM @ 10 t ha^{-1} + biofertilizers (*Azospirillum* + phosphobacteria @ 3 kg ha^{-1} each)

T_3: FYM @ 15 t ha^{-1}

T_4: FYM @ 15 t ha^{-1} + biofertilizers (*Azospirillum* + phosphobacteria @ 3 kg ha^{-1} each)

T_5: FYM @ 10 t ha^{-1} + organic sources to substitute NPK @ 50:25:75 kg ha^{-1} (i.e., FYM @ 20 t ha^{-1} + rock phosphate (RP) @ 25 kg ha^{-1} + wood ash (WA) @ 2 t ha^{-1})

T_6: T_5 + biofertilizers (*Azospirillum* + phosphobacteria @ 3 kg ha^{-1} each)

T_7: Control (no manure, no biofertilizer)

Prior to the experiment, soil samples were collected from each location for mechanical and chemical analyses using standard procedures (Jackson, 1973). The results indicated that the soils were acidic (pH: 4.5-6), medium to high in organic C (0.7-0.9%), medium in available N (313.6-427.2 kg ha^{-1}) and available K (112-224 kg ha^{-1}) and high in available P (24.6-54.8 kg ha^{-1}) contents.

The required quantities of farmyard manure, rock phosphate and biofertilizers were applied in the raised beds before planting. Rhizome pieces of 15-20 g were planted on raised beds at a spacing of 30 cm x 15 cm and mulched with dry leaves @ 15 t ha^{-1}(Suja and Nayar, 2005). Wood ash was applied two months after planting along with first intercultural operation and earthing up. The second weeding and earthing up were done four months after planting. The crop was harvested nine months after planting during both the years at all locations and the rhizome yield was recorded. At harvest, plot wise fresh samples of rhizomes were collected at all locations and analysed for qualitative characters like dry matter, starch, crude protein and crude fibre contents as per standard procedures (AOAC, 1980). The experimental data were analysed statistically by applying the technique of analysis of variance (ANOVA) for randomized block design with seven treatments and three replications at five locations (Cochran and Cox, 1965).

Results and Discussion

Application of different levels of organic manure and biofertilizers produced significant influence on rhizome yield (Table 1) and quality characters of arrowroot intercropped in the coconut garden (Table 2). The yield data during both the years as well as the pooled data (Table 1) indicated the sufficiency of application of FYM @ 15 t ha^{-1} + biofertilizers for realizing higher yield from arrowroot intercropped in coconut.

Quality characters of rhizome

Dry matter

As in the case of rhizome yield (Table 1), the dry matter content of rhizome improved during the second year due to the various treatments (Table 2). During the first year, the highest content of dry matter of rhizome was observed

Table 1. Effect of levels of organic manure and biofertilizers on rhizome yield of arrowroot intercropped in coconut

Treatments		Rhizome yield (t ha^{-1})		
		2007-2008	2008-2009	Pooled mean
T_1	FYM @ 10 t ha^{-1}	12.54	18.38	15.46
T_2	FYM @ 10 t ha^{-1} + biofertilizers	13.73	19.25	16.49
T_3	FYM @ 15 t ha^{-1}	14.81	20.14	17.47
T_4	FYM @ 15 t ha^{-1} + biofertilizers	15.78	21.45	18.62
T_5	FYM @ 20 t ha^{-1} + RP @ 25 kg ha^{-1} + WA @ 2 t ha^{-1}	15.27	21.29	18.28
T_6	FYM @ 20 t ha^{-1} + RP @ 25 kg ha^{-1} + WA @ 2 t ha^{-1} + biofertilizers	16.50	22.18	19.34
T_7	Control	9.24	11.94	10.59
	CD (0.05)	1.114	1.408	0.88

FYM: Farmyard manure; RP: Rock phosphate; WA: Wood ash

Table 2. Effect of levels of organic manure and biofertilizers on quality characters of arrowroot intercropped in coconut

Treatments	Dry matter (%)			Starch (%) (FW basis)			Crude protein (%) (FW basis)			Crude fibre (%) (FW basis)		
	2007-08	2008-09	Pooled mean	2007-08	2008-09	Pooled mean	2007-08	2008-09	Pooled mean	2007-08	2008-09	Pooled mean
T_1 FYM @ 10 t ha^{-1}	25.00	25.16	25.08	24.33	25.95	24.64	0.91	0.98	0.94	2.83	4.04	3.43
T_2 FYM @ 10 t ha^{-1}+ biofertilizers	27.07	30.97	29.02	25.56	25.84	25.70	0.94	1.03	0.99	3.34	3.96	3.65
T_3 FYM @ 15 t ha^{-1}	26.60	28.85	27.73	25.46	25.39	25.42	0.94	1.00	0.97	3.22	4.17	3.69
T_4 FYM @ 15 t ha^{-1}+ biofertilizers	27.80	30.89	28.35	26.91	26.40	26.66	0.99	1.10	1.04	3.57	4.09	3.83
T_5 FYM @ 20 t ha^{-1}+ RP @ 25 kg ha^{-1}+ WA 2 t ha^{-1}	26.47	27.68	27.07	26.91	26.37	26.64	0.99	1.05	1.02	3.29	4.37	3.83
T_6 FYM @ 20 t ha^{-1}+ RP @ 25 kg ha^{-1}+ WA@ 2 t ha^{-1} + biofertilizers	26.87	30.63	28.75	27.81	27.09	27.45	1.04	1.09	1.07	3.65	4.12	3.88
T_7 Control	21.07	24.14	22.99	21.53	22.61	22.07	0.81	0.82	0.82	2.72	3.31	3.01
CD (0.05)	2.009	1.903	1.178	1.065	0.861	0.737	0.042	0.055	0.036	0.268	0.314	0.225

FYM: Farmyard manure; RP: Rock phosphate; WA: Wood ash

in FYM @ 15 t ha^{-1}+ biofertilizers, which was on par with the other treatments, except FYM @ 10 t ha^{-1}and control. During the second year, the highest content of dry matter was obtained under FYM @ 10 t ha^{-1}+ biofertilizers, which was on par with FYM @ 15 t ha^{-1}+ biofertilizers and FYM @ 20 t ha^{-1}+ RP @ 25 kg ha^{-1} + WA @ 2 t ha^{-1}+ biofertilizers indicating the significant influence of biofertilizers. The same trend was shown by the pooled data over the years. Similar results were obtained under organic management in elephant foot yam and yams (Suja et al., 2010; 2012a; 2012b; Suja, 2013).

Starch

There was no marked variation in starch content of rhizomes between first and second years (Table 2). During both the years, application of even 10 t ha^{-1}of FYM produced significant increase in starch content over control. The highest starch content was noticed under FYM @ 20 t ha^{-1}+RP @ 25 kg ha^{-1}+ WA @ 2 t ha^{-1}+ biofertilizers (T_6), which was on par with FYM @ 15 t ha^{-1}+ biofertilizers (T_4) during both the years. The pooled data indicated the significant effects of biofertilizers and the highest starch content under T_6 closely followed by T_4.

Crude protein

In general, the crude protein content of rhizome increased with increase in the level of organic manure (Table 2). Corroboratory results have been reported by Veenavidyadharan and Swadija (2000) in arrowroot. The crude protein content also improved during the second year as in the case of dry matter and starch contents, indicating improvement in quality characters (Table 2) besides improvement in rhizome yield (Table 1) by two years. Suja (2013) also reported similar results in tuberous vegetables, elephant foot yam and yams, under organic management. The highest content of crude protein was noticed under FYM @ 20 t ha^{-1}+ RP @ 25 kgha^{-1} + WA @ 2 t ha^{-1}+

biofertilizers (T_6) during the first year and by FYM @ 15 t ha^{-1} + biofertilizers (T_4) during the second year. Pooled analysis indicated the significant effect of biofertilizers and the highest content of crude protein in T_6, which was on par with T_4.

Crude fibre

An increasing trend in crude fibre content of rhizome with increasing levels of FYM was observed in the present study (Table 2). During the first year, the lowest content of crude fibre was obtained under FYM @ 10 t ha^{-1} among all the treatments except control. During the second year, the effects of all treatments, except control were on par. The year wise data and the pooled data failed to express significant effect of biofertilizers. The pooled data indicated that the lowest crude fibre content was observed due to the application of FYM @ 10 t ha^{-1} which was on par with FYM @ 10 t ha^{-1}+biofertilizers. So application of a lower dose of FYM was necessary for producing lower content of crude fibre of rhizomes as reported by Veenavidyadharan and Swadija (2000) also in arrowroot.

Conclusion

The results indicated that the quality characters of rhizomes of arrowroot like dry matter, starch and crude protein contents improved during both the years of study due to application of even10 t $ha^{-1}$of FYM over control. The study revealed the sufficiency of FYM @ 15 t ha^{-1} + biofertilizers (*Azospirillum* + phosphobacteria) for realizing higher rhizome yield and improved rhizome quality of arrowroot intercropped in coconut.

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