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REMOVAL OF NUTRIENTS AS INFLUENCED BY VARIED RATES OF RECOMMENDED NUTRIENTS IN CONJUNCTION WITH BIOFERTILIZERS IN LOCAL LANDRACES OF PADDY IN COASTAL AREA OF KARNATAKA, INDIA

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ABSTRACT

The uptake of nutrients by the paddy crop better indicative of the fertility, productivity, and plant nutrient status. The main objective of this investigation was that the rate of nutrient application can influence the removal of nutrients into formsavailable to the soil with different landraces in conjunction with the application of different microbial inoculants under different fertility levels. The yield of landraces was significantly influenced by the microbial inoculants under different fertility levels.Significantly higher uptake of N, P and K was observed in the landrace padmarekha compared to other landraces. The nutrient removal from the soil was in the range of 81.57 – 104.08 kg N, 19.55 -33.96 kg P and 88.15 – 111.81 kg/ha Kamong landraces. Similarly, the higher uptake was seen with the application of 100 per centRDF along with the azospirullum, Bacillus megatherium var. Phosphoticum Frateuria quaratia,Thiobacillus thiooxidans and Vesicular ArbescularMycorrizae.The nutrient removal was in the range of 47.11-122.0 kg N, 10.71-36.7 kg P2O5 and 34.22- 141.21 kg/ha K2O among fertility levels in different paddy landraces used in the study. The different microbial inoculants application with the recommended dose of fertilizers in different levels helped in the acquisition of the nutrients from the soil solution illustrating the effects of microbial applications through the increased supply of biologically fixed nitrogen, mobilizing the phosphorus towards plant roots, and potassium availability to the crop. Thus, our investigations acclaim that there is a need to inoculate the crop with different microbial inoculants to increase the use and uptake of the nutrients by the crop and improvement in soil nutrient status.

Keywords: landraces, biofertilizers, yield, uptake

INTRODUCTION

Rice (*Oryza sativa* L.) is aprime source of energy in terms of carbohydrates and proteins considered by FAO a premeditated crop for food security of the world population due to its ample adaptation to climates and soils (FAO, 2006). Rice feeds more than half the world population with high calorific value (78.2% carbohydrate, 6.8% protein, 0.5% fat, and 0.6% mineral matter) (Mousmumi and Anwesha, 2019).

Rice growers have the impression that the dependency on chemical fertilizers is necessary for high yields. However, chemical fertilizers haveamonopoly on the source of nutrients in the production systems.The increase in productivity in the current situation in rice is often related use of chemical fertilizers in geometric rates (Hider 2018). It is also expected an increase in the amount of chemical fertilizer to be applied (Singh *et al.,* 2014; Ladha and Reddy, 2003) which parallelly increase the cost of production to the farmers. On the contrary,The reduction or elimination of subsidies on chemical fertilizers would be tough for the small farmers to afford fertilizers to the crop (Singh Y V, 2013).Thus the reduction means and methods to its reduction in usage are the major concern of the day.The literature has shown that only one-third of the applied N is utilized by the rice plants while the other one-third remains in the soil at the crop harvest and the rest is lost as gas to the atmosphere, mostly through ammonia volatilization (Singh and Shivay, 2003; Buresh *et al.,* 2008) causing a global risk of environmental pollution. Thus, it is imperative to find substitutes to reduce the use of chemical fertilizers applied to rice crop and improve the efficiency of applied fertilizersandwithout causing risks of environmental pollution.

Fertilizers usage in conventional rice cultivation reported having poor nutrient use efficiency due to excessive use of water and readily available nature of nutrients in fertilizers. The rice production systems have increased theirdependence on chemical fertilizers for few decades leading to depletion of soil fertility and other soil-related constraints. Due to over-exploitation of the resources, the deficiency of several other nutrients has become a major issue. The organic production systems are desirable in the present day's context because of the soil-related constraints face by the farmers but become less feasible due to an increase in demand for organic manure making it costlier. However, the quality of food and nutritional security, and soil health have to be protected without any reduction in production. Hence, it is desirable to adopt an integrated approach in meeting the nutrient demand of the crop beside it partly addresses the current burning problems too.Thus, efficient utilization of existing land and available water beside the practical application of organic and mineral fertilizers helps in attaining sustainability in rice production (Hider 2018). This approach involves the application of chemical fertilizers, organic sources, and bio-fertilizers to bridge the gap between nutrient demand and supply to improve the grain yield. Using bio-fertilizers deserves priority for sustained production and better resource utilization in integrated nutrient management.Bio-fertilizer is a low-cost source that has gained momentum in recent decades and plays a crucial role in maintaining long-term soil fertility and sustainability. Therefore, increased yield levels with reduced environmental risk while preserving the soil health simultaneously require new cultivation strategies that incorporate the use of biological fertilizers (Hegde et al 1999). The biofertilizers were developed based on the observation that these microorganisms can have a beneficial effect on plant and crop growth (Davidson, 1988; Nino et al 2012). These are applied in a supplement to chemical fertilizer in sustainable agriculture. (Mousmumi and Anwesha, 2019), Integrated use of bio-fertilizers in rice offers an inexpensive, low capital intensive and eco-friendly route to boost rice productivity.

Biofertilizers comprise selective micro-organisms like bacteria, fungi and algae which are capable of fixing atmospheric nitrogen or mobilize or convert insoluble phosphate, potassium and sulphate in the soil into forms available to plants (Nino et al 2012). At present, the atmospheric nitrogen (N) fixing capacity of many microorganisms has been made as a point of modern agronomic interest.The nitrogen-fixing bacteria or diazotrophs association with rice varieties is one substitute that has been strategically thought to replace part of the N fertilizer required by the plant and also, indirectly helping the plant to assess other added or naturally available nutrients present in the soil (Antonio *et al.,* 2013). Generally, N fixing and P solubilizing inoculants are important biofertilizers used in rice crop (Mao et al 2018).Nowadays, the available multistrain biofertilizer with different functions has more efficientFurthermore, biofertilizers containing many strains can supply more growth phytohormone known to increase 15-50% more growth than chemical fertilizer applications (Panhwar et al 2014).

Many traditional varieties and improved cultivars have been released for cultivation in different regions of India (Shailesh *et al.,* 2015). In Karnataka, wide variety of rice germplasm is available and being utilized successfully in the rice breeding programs. However, few of the landraces are still being grown by the farmers for their uniqueness in taste and productivity which is in line with high-yielding varieties thus preferred. The productivity of paddy landraces in the coastal climateiscomparatively lower than its potential yield due to inadequate and improper time of application of nutrients that need immediate attention. Due to lack of awareness among the farmers, the use of N fertilizer to these landraces in adequate quantity is still limiting which has an impact on poor yield productivity. Besides this, the heavy rainfall in coastal areas results in the leaching of nutrients like, nitrogen and potassium which leads to poor fertility. Therefore, these traditional landraces might have acted as a "selective filter" on the diazotrophic bacterial population associated so that only more efficient genotype/bacteria interactions could have been established over the years. In the present study, we have used the complementary options of using microbial consortia for N fixing and P solubilizing microbial inoculants to mainly keeping in the view of increasing productivity.

Till now the work on the diazotrophic bacterial population in combination with mineral fertilizers in coastal areas traditional landraces of rice is limiting. Thus, a technological innovation concerning nutrient management by integrating the different sources for improving the nutrient use efficiency is essential to improve the productivity in coastal areas. Thus, keeping these points in view, an investigation "Removal of nutrients as influenced by varied rates of recommended nutrients in conjunction with bio-fertilizers in local landraces of paddy in coastal areas of Karnataka" was carried out during *kharif* 2017 and 2018 inafarmers field in coastal climate at Mirjan village of Kumta taluk, Uttara kannadadistrictof Karnataka, India to study the impact of bio-fertilizers and chemical fertilizers combination on growth and development of local paddy landraces to improve the income of the rice growers.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted in *kharif* seasons during 2017 and 2018 in farmer's field at Mirjan village, Kumta taluk, Uttarakannada district (Karnataka) located at $14^0$42' 33.8'' North longitude and 74^0 4' 27.6'' East longitudes. It is representative of the agro-ecological sub-region 19.3 covering Karnataka coast of around 350 km (Sehgal *et. al.* 1995) with an elevation of 603 meters above mean sea level in thecoastal zone (zone 10) of Karnataka. The climate is strongly influenced by the monsoons, and the climate is tropical, moderated by proximity to the sea. During the monsoons, the region receives one of the heaviest rainfalls in India averaging 2877 mm.

Soil characters

The soil of the experimental site was loamy sand in texture. The moisture content at field capacity was 17.5 per cent at 0-15 cm layer with a bulk density of 1.56 g/cc. The soil was acidic in reaction (pH 5.34) and electrical conductivity was 0.05dS\m. The organic carbon content was 1.66 per cent. The available nitrogen (442.5 kg/ha), phosphorus (9.2 kg/ha), potassium (105.5kg/ha), sulphur (710.0g/ha) and zinc (560.0 g/ha).

Table 1: Grain and straw yield (q/ha) of paddy landraces as influenced by different fertilizers levels in conjunction with biofertilizers practices in coastal area of Kumtataluk. uttarakanndadistrict,Karnataka, India.

Land races	**Grain yield (q/ha)**			**Straw yield (q/ha)**		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
M_1: *Hal doddiga*	64.02	63.13	63.58	74.45	73.52	73.98
M_2: *Mysore sanna*	63.12	61.17	62.14	74.58	72.02	73.30
M_3: *Padmarekha*	67.04	65.37	66.20	73.92	75.38	74.65
M_4: *Halga*	63.62	62.41	63.01	74.08	71.45	72.77
M_5: *Kemp jaddabhatta*	63.89	62.14	63.02	72.06	74.00	73.03
M_6: *Kari kagga*	45.24	47.12	46.18	56.84	59.21	58.03
Mean	61.15	60.22	60.69	70.99	70.93	70.96
S.Em±	0.97	0.83	0.62	1.42	0.75	0.65
LSD (P=0.05)	3.54	3.03	2.26	5.17	2.74	2.36
Fertility levels						
S_1:Farmers practice	55.0	51.8	53.4	61.7	61.6	61.7
S_2: 50 % RDF+bio-fertilizers	58.5	58.7	58.6	68.8	70.0	69.6
S_3: 75 % RDF+ bio-fertilizers	63.7	58.7	63.7	75.6	73.4	75.5
S_4: 100 % RDF+ bio-fertilizers	67.4	63.8	67.0	77.9	75.8	77.2
Mean	61.15	60.22	60.69	70.99	70.93	70.96
S.Em±	0.63	0.75	0.46	0.95	0.91	0.70
LSD (P=0.05)	1.83	2.15	1.33	2.75	2.62	2.01
Interaction (MxS)						
S.Em±	1.26	1.49	0.92	1.90	1.81	1.39
LSD (P=0.05)	NS	4.31	2.65	NS	NS	NS

Note:

1.Biofertilizers include Azospirillum + Bacillus megatherium var. Phosphoticum + Frateuria quaratia + Thiobacillus thiooxidans +Vesicular ArbescularMycorrizae

2.Farmers Practice include only application of NPK as mentioned in methodology without any biofertilizers.

Table 2: Total dry matter accumulation at harvest (g/hill) and plant height (cm) of paddy landraces as influenced by different fertilizers levels in conjunction with biofertilizers practices in coastal area of Kumta taluk. uttarakannda district, Karnataka, India.

Land races	Total dry matter accumulation			Plant height		
	2017	2018	Pooled	2017	2018	Pooled
M_1: *Hal doddiga*	49.35	49.98	49.67	112.48	110.72	111.60
M_2: *Mysore sanna*	53.89	49.86	51.88	113.42	111.70	112.56
M_3: *Padmarekha*	52.04	52.37	52.20	117.78	115.03	116.41
M_4: *Halga*	48.61	49.25	48.93	109.83	105.87	107.85
M_5: *Kemp jaddabhatta*	47.61	47.36	47.48	115.75	111.62	113.68
M_6: *Kari kagga*	38.53	38.38	38.45	100.72	101.33	101.03
Mean	48.34	47.87	48.10	111.66	109.38	110.52
S.Em±	0.68	0.53	0.36	0.89	1.16	0.70
LSD (P=0.05)	2.47	1.94	1.32	3.25	4.22	2.56
Fertility levels						
S_1:Farmers practice	20.8	21.2	20.99	99.3	95.6	97.43
S_2: 50 % RDF+bio-fertilizers	49.4	48.7	49.1	109.8	108.5	109.2
S_3: 75 % RDF+ bio-fertilizers	58.6	59.0	58.8	116.8	116.3	119.0
S_4: 100 % RDF+ bio-fertilizers	64.5	62.6	63.5	120.8	117.1	119.0
Mean	48.34	47.87	48.10	111.66	109.38	110.52
S.Em±	0.63	0.79	0.54	1.08	1.47	1.83

LSD (P=0.05)	1.83	2.29	1.56	3.12	4.24	2.64
Interaction (MxS)						
S.Em±	1.27	1.81	1.08	2.16	2.93	1.83
LSD (P=0.05)	3.66	NS	3.13	NS	NS	NS

Note:
3.Biofertilizers include Azospirillum + Bacillus megatherium var. Phosphoticum + Frateuria quaratia + Thiobacillus thiooxidans +Vesicular ArbescularMycorrizae
4.Farmers Practice include only application of NPK as mentioned in methodology without any biofertilizers.

Table 3: Uptake of nitrogen, phosphorus and potassium (kg/ha) of traditional paddy landraces as influenced by different fertilizers levels in conjunction with biofertilizers practices in coastal area of Kumta taluk. uttarakanndadistrict, Karnataka, India.

Varieties	**Uptake of N**			**Uptake of P2O5**			**Uptake of K2O**		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
M_1: *Hal doddiga*	89.97	94.19	92.08	30.25	31.02	30.63	101.86	105.53	103.86
M_2: *Mysore sanna*	79.58	67.12	81.57	29.55	30.64	30.10	99.11	102.78	101.11
M_3: *Padmarekha*	102.78	91.64	104.08	33.79	34.13	33.96	108.10	113.48	111.81
M_4: *Halga*	88.88	84.67	90.79	27.55	30.38	28.96	94.02	97.27	95.60
M_5: *Kemp jaddabhatta*	92.66	94.45	94.48	26.63	28.84	27.74	92.14	95.81	94.14
M_6: *Kari kagga*	54.79	50.54	56.39	19.18	19.92	19.55	85.11	89.81	88.15
Mean	84.78	80.44	86.57	27.83	29.15	28.49	96.72	100.78	99.11
S.Em±	1.42	1.15	2.34	0.60	0.56	0.32	1.37	1.57	1.57
LSD (P=0.05)	16.64	4.18	8.50	2.18	2.05	1.18	4.98	5.71	5.71
Fertility levels									
S_1:Farmers practice	47.1	47.1	47.11	9.0	10.71	9.9	32.22	35.89	34.22
S_2: 50 % RDF+bio-fertilizers	82.1	85.8	84.5	32.1	32.8	32.4	96.27	99.93	98.27
S_3: 75 % RDF+ bio-fertilizers	96.3	101.3	98.9	34.3	36.4	35.4	120.75	124.42	122.75
S_4: 100 % RDF+ bio-fertilizers	113.7	86.6	122.0	35.9	36.7	36.3	137.65	142.87	141.21
Mean	84.78	80.44	86.57	27.83	29.15	28.49	96.72	100.78	99.11
S.Em±	2.73	1.56	1.62	0.86	0.50	0.46	1.87	1.88	1.88
LSD (P=0.05)	7.89	4.51	3.80	2.47	1.44	1.33	5.39	5.42	5.42
Interaction(MxS)									
S.Em±	5.46	3.12	2.63	1.12	0.94	0.60	1.35	1.48	1.49
LSD (P=0.05)	15.78	9.01	7.60	3.23	2.72	1.72	3.91	NS	NS

Note:
Biofertilizers include Azospirillum + Bacillus megatherium var. Phosphoticum +Frateuria quaratia + Thiobacillus thiooxidans +Vesicular ArbescularMycorrizae

Table 4: Available Nitrogen (N), Phosphorus (P2O5) and Potassium (K2O) (kg/ha) in the soil after harvest of paddy landraces as influenced by different fertilizers levels in conjunction with biofertilizers practices in coastal area of Kumta taluk. uttarakannda district, Karnataka, India.

Varieties	**Uptake of N**			**Uptake of P2O5**			**Uptake of K2O**		
	2017	**2018**	**Pooled**	**2017**	**2018**	**Pooled**	**2017**	**2018**	**Pooled**
M_1: *Hal doddiga*	182.50	192.25	187.38	22.07	23.17	22.62	195.98	196.73	196.36
M_2: *Mysore sanna*	186.25	194.00	190.13	23.19	23.50	23.35	197.86	198.59	198.23
M_3: *Padmarekha*	187.67	195.33	191.50	24.41	25.43	24.92	201.88	202.62	202.25
M_4: *Halga*	185.67	194.33	190.00	23.89	24.93	24.41	198.83	199.59	199.21
M_5: *Kemp jaddabhatta*	182.83	195.17	189.00	21.58	22.32	21.95	199.65	200.42	200.03
M_6: *Kari kagga*	177.58	186.14	181.86	20.41	20.45	20.43	192.38	193.22	192.80
Mean	183.75	192.87	188.31	22.59	23.30	22.95	197.76	198.53	198.15
S.Em±	2.85	2.07	1.78	0.41	0.30	0.30	0.04	0.05	0.03
LSD (P=0.05)	NS	NS	NS	1.51	1.08	1.10	0.16	0.18	0.11

Fertility levels									
S_1:Farmers practice	164.89	173.89	169.4	14.19	15.22	14.71	191.04	191.78	191.41
S_2: 50 % RDF+bio-fertilizers	172.5	180.3	176.4	19.57	20.66	20.11	195.38	196.17	195.77
S_3: 75 % RDF+ bio-fertilizers	193.4	203.2	198.3	24.78	25.24	25.01	200.32	201.07	200.69
S_4: 100 % RDF+ bio-fertilizers	204.2	214.1	209.2	31.83	32.08	31.95	204.31	205.10	204.71
Mean	183.75	192.87	188.31	22.59	23.30	22.95	197.76	198.53	198.15
S.Em±	2.81	3.34	1.89	0.94	0.38	0.51	0.03	0.03	0.02
LSD (P=0.05)	8.12	9.64	5.46	2.70	1.08	1.46	0.10	0.10	0.07
Interaction(MxS)									
S.Em±	1.93	1.52	1.20	1.01	0.59	0.65	0.03	0.03	0.02
LSD (P=0.05)	NS	NS	NS	NS	1.70	1.88	0.08	0.09	0.05

Note:
Biofertilizers include Azospirillum + Bacillus megatherium var. Phosphoticum +Frateuria quaratia + Thiobacillus thiooxidans +Vesicular ArbescularMycorrizae

Treatment details

The experiment was laid out in split-plot design with 24 treatment combinations and three replications. The main plots (M) consists of six paddy landraces, M_1-*Hal doddiga*, M_2-*Mysore sanna*, M_3-*Padmarekha*, M_4-*Halga*, M_5-*Kempjaddabhatta* and M6-*Karikagga*. In subplot (S) there were four different bio-fertilizer and chemical fertilizer combinations are taken for study as follows:S_1= Farmers practice, S_2=50% RDF+*Azospirllum*+ PSB + K-solubilizer +S-solubilizer +VAM, S_3=75%RDF+*Azospirllum*+PSB+K-solubilizer+S-solubilizer+VAM,S_4=100% RDF+*Azospirllum*+*Bacillus megatherium* var. Phosphoticum + *Frateuria quaratia* + *Thiobacillus thiooxidans* +Vesicular ArbescularMycorrizae.

The Farmers practice is 100 kg complex fertilizers (15:15:15), 50 kg urea, 50 kg MOP, 1.5 tonnes of FYM,nozinc sulphate, no lime, and no biofertilizers in farmers' practice and other agronomic practices are the same as treatment plots. This treatment is used as a control plot to compare the effect of different microbial inoculants with different fertility levels.

The fertilizer $ZnSO_4$ 25 kg/ha, FYM 5.0 t/ha,and lime 500 kg/hawere applied to all the treatments except farmer's practice. Seedlings were raised in a nursery bed and 21 days old 2-3 old seedlings were transplanted in the main field at 20X10cm spacing. Seedlings of respective treatments were inoculated with bio-fertilizers slurry. After inoculation, the inoculated and uninoculated seedlings were transplanted. A fertilizer dose of N:P:Kat 75:75:90 kg/ha was given in two split doses as per the recommendation.The full quantity of P_2O_5 and K_2O and 50% NFertilizerwere given at the time of sowing and the remaining quantity at the tillering stage. Urea, diammonium phosphate, and muriate of potash fertilizers were used as fertilizers to the crop.

Data collection

Data on crop traits

Five observation plants were tagged and periodical observations were recorded from the same plants and expressed as the mean of five plants. Tillering was recorded by counting the number of tillers on a hill. The plant height (i.e., height of the rice plant from node separating root and shoot up to the tip of the panicle) was measured using a meter and centimeter graduated flexible metal ruler. The plant samples collected at the border rows for destructive samplings like dry matter accumulation and distribution were shade dried for few days followed by oven drying at 70^oC until a constant weight was obtained.

At physiological maturity plant samples from each plot were harvested manually and separated into straw and panicles. The dry weight of straw was determined after oven drying at 70^0C for 48 hours to constant weight. Panicles were hand-threshed and the filled spikelets were separated from unfilled spikelets with a blower. Further, the number of filled, unfilled, and total spikelets were counted and calculated the spikelet fertility (%). Grain yield was determined from each net plot and adjusted to the standard moisture content of 14% moisture and data is converted from per plot to per hectare. Biomass yield was the sum of the straw or the vegetative part and the seed/ grain or the reproductive part of the crop plant.

Soil organic carbon was determined using the wet digestion method of Walkely and Black (1934). Available N was measured by the alkaline permanganate method as described by Subbiah and Asija (1956). Available P was determined by the Bray II method (Bray and Kurtz 1945). Available K was extracted by 1 M ammonium acetate (pH = 7.0) and determined by flame photometry (Jackson 1973).

RESULTS AND DISCUSSION

Influence of growth and yield of traditional paddy landraces under different fertility levels along with biofertilizers

The growth and yield of local paddy landraces were positively influenced by the increasing application of fertility levels up to the highest level wherein 100% of the recommended NPK accompaniedbiofertilizers to paddy.The better vegetative growth leading to enhanced yield productivity under the highest fertility levels was occurred due to the greater absorption of nutrients through adequate availability and supply of N, P, and K under the highest level which led to increased photosynthates accumulation and higher biomass production due to high rate of synthesis of protoplasmic protein and in turn, protein synthesis increases the cell size, which is mainly responsible for vertical development of plants (Nova and Loomis, 1981). Significantly higher grain yield was recorded with the land-race padmarekha recording a mean yield of 66.2 q/ha. Further, the land-races Hal doddiga (63.58 q/ha), Halga (63.01 q/ha) and Kemp jaddabhatta (63.02 q/ha), and Mysore sanna (62.14 q/ha) remained comparable with each other and the genotype Kari kaggasignificantly recorded the lowest grain yield (46.18 q/ha). Whereas the higher straw yield was recorded with all genotypes except Kari kagga (58.03 q/ha).. With the application of biofertilizers along with various levels of the recommended dose of fertilizers, there was a significant influence on the growth and yield of paddy landraces. The highest yield of 67.0 q/ha was recorded with the application of 100% RDF + *Bacillus megatherium* var. Phosphoticum + *Frateuria quaratia* + *Thiobacillus thiooxidans* +Vesicular ArbescularMycorrizae. The interaction effect of paddy landraces with RDF and biofertilizers differed significantly concerning grain yield. The yield of all the genotypes performed steadily higher under the treatment with the application of 100% RDF with biofertilizers (*Bacillus megatherium* var. Phosphoticum + *Frateuria quaratia* + *Thiobacillus thiooxidans* +Vesicular ArbescularMycorrizae) over both the years. The highest mean grain yield of 66.2 q/ha was recorded with Padmarekha.

It is a well-established fact that the total dry matter accumulation mainly consists of a better formation of the photosynthates which depends on the moisture, nutrients, and availability of light that assimilated in the growth and development of new leaves, tillers as well as roots. The improved fertility levels (N,P,K) supplying capacity of soil under the higher fertilizer doses might have collectively resulted in better growth and development of paddy. The variety *Padmarekha* has produced significantly higher total dry matter (52.2 g/hill) at harvest over the other landraces. The higher dry matter accumulation of *Padmarekha* may be attributed to higher total dry matter production through taller plant height of (116.41 cm), higher growth and yield traits at harvest as a result of better utilization of light and nutrients as compared to other landraces. The increase in dry matter and yield could be due to the effective utilization of added nutrients and released nutrients by added biofertilizers in the soil solutions besides the inherent nutrients from the soil. This, in turn, increased the biological activity leading to an increase in crop height, tillering ability of plants promoting higher physiological activity leading to higher photosynthetic rate in plants (Gangadharaiah (1983), Basavaraja (2007) and Raghunandha Reddy (1986) The significantly improved growth attributes observed in the landrace Padmarekha might be due to its varietal vigour, enabling it better utilization capacity of available nutrients, moisture and space (VeerajUrs and Mahadevappa, 1972) and Yogananda and Reddy, 2004.

The application of bio-fertilizers along with chemical fertilizers significantly influenced the grain yield in landraces of paddy. The 20 per cent higher grain yield was achieved when supplied by 100 per cent RDF with bio-fertilizers as compared to farmers practice, while it recorded 5 per cent and 13 per cent yield improvement over the decreasing fertility levels, respectively (Table 1). This significant yield increase was primarily due to increased yield attributing parameters and total dry matter production.Sudha and Chandini, 2003 reported that the application of biofertilizers and vermicompost at 5 t/ha had a positive influence on growth and yield attributes of rice and resulted in a better grain yield of 4.54 t/ha and straw yield of 5.15 t/ha along with the NPK dose of 105:52.5:52.5 kg/ha supplied through inorganic sources.

The prerequisite to getting higher yield in any crop is to have higher total dry matter production and its partitioning into various plant parts, coupled with the maximum translocation of photosynthates to the sink. Significantly higher total dry matter per hill was recorded with 100 per cent RDF along with bio-fertilizers (63.5 q/ha) at harvest as compared to farmers practice (20.99 q/ha), 50 per cent RDF+bio-fertilizers (49.1 q/ha) and 75 per cent RDF+bio-fertilizers (58.8 q/ha). The application of bio-fertilizers helped in the stable availability of nutrients at all stages which promoted the effective growth of crop.Besides growth and development, the improved soil aggregation, higher quantity of nutrient availability and enhanced soil microbial activity, resulting in congenial soil condition with a consequentlyimproved uptake of nutrients has led to more vegetative growth of the plants and also higher dry matter. Increased total dry matter influenced the higher straw and grain yield. The higher total dry matter per hill might be due to the higher number of tillers per hill produced through increased shoot growth increased physiologically active green leaves provided scope for increased photosynthetic activity. Similar findings were recorded by earlier workers Vasanthi and Kumaraswamy, 1996 in paddy.

Significantly the tallest plant height of 119 cm at harvest was recorded with 100 per cent RDF along with bio-fertilizers as compared to farmers practice (97.4cm), 50 per cent RDF along with bio-fertilizers (109.2 cm) and 75 per cent RDF along with biofertilizers (119.0 cm) at harvest (Table 2). The taller plants can be attributed due to greater availability and accelerated or steady release of nitrogen in this treatment with the influence of the *Azospirullum,* which was compatible in the rhizosphere of the traditional landraces of paddy provided an opportunity for greater acquisition and utilize higher quantum of nutrients from bio-fertilizers. Several workers like Devaraju, *et al.,* 1998, Ravi and Srivasthava, 1997, reported that adequate supply of plant nutrients influenced plant growth and yield relating to greater release of nutrients during successive crop growth stages by organic sources of nutrients including biofertilizers.

Influence on nutrient uptake under different fertility levels and biofertilizer application in traditional paddy landraces.

Higher uptake also depends on the genotypic root character of the genotypes. Significantly higher nutrient uptake was observed in Padmarekha (104.08 kg N/ha, 33.96 kg P_2O_5/ha, 111.81 kg K_2O/ha) compared to other landraces (Table 3). With the gradual increase in fertility levels from 50 to 100 per cent to paddy, resulting inaregular upsurge in nutrients availability that in turned good yield and better nutrient contents (N,P,K) in the grainsand straw that ultimately converted into larger uptake by the crop. Our results were in line with the work reported by numerous researcher, where larger uptake of nitrogen (122.0 kg/ha), phosphorus (36.3kg/ha), potassium (141.21 kg/ha) were recorded when supplied 100 RDF along with biofertilizers and it significantly differed to other combinations of fertilizer levels and biofertilizers (Table 3). The higher nutrient uptake was mainly due to improvedroot development, encouraging dry matter production and accumulation which in turn helps in the synthesis of higher yield (Jeena *et al.,* 2006). Nutrient losses with the use of organic nutrient sources and biofertilizers is comparatively lower efficiency is higher which results in higher nutrient uptake(Jayadeva, 2007). Thus it can conclude that the increased uptake and nutrient availability as a consequence of a synergistic relationship between the biofertilizers and inorganic sources. Similar results were reported by Subramanian and Kumaraswamy (1989), Katyal and Sharma (1979) and Jadhav *et al.,* (1997).

ThePadmarekha landrace with an application of 100 per cent RDF with biofertilizers recorded higher uptake of nutrients followed by 75 per cent RDF along with biofertilizers. This genotype performed well during both the years of experimentation with different fertility levels including the farmers' practice. The supply of recommended dose of nutrients in conjunction with different nutrient solubilizes in the form of biofertilizers had good compatibility in dissolving the complex nutrient ions to simpler forms making easy availability of nutrients to the crops plants. The bio inoculants in a combination of the existing microorganisms in the native soils of the site of the experiment would have increased the root and shoot growth and inturn acquisition of the nutrients ions in the plant rhizosphere of the crop. This conforms with the work of Yogananda and Reddy (2004) and Murali and Setty (2001). Thus using biofertilizers deserves priority for sustained production and better resource utilization in integrated nutrient management i.e., use of biofertilizers with inorganic fertilizers in traditional paddy landraces. Thus, the present study confirms the maximization of the yields of traditional paddy landraces could be possible using the bio inoculants along with chemical fertilizers besides improving nutrient uptakeand utilization of the applied nutrients in the coastal region of Karnataka.

CONCLUSION

The study conducted during 2017 and 2018 in the farmer's field of coastal Karnataka reveals that the traditional landrace productivity could be improved using a 100% recommended dose of fertilizers (75:75:90 NPK) in combination with *Azospirillum* + *Bacillus megatherium* var. Phosphoticum +Frateuria quaratia + *Thiobacillus thiooxidans* +Vesicular ArbescularMycorrizae. The effectiveness of nutrient management could be further improved by adding 5 tonnes of FYM, 500 kg of lime and 25 kg of $ZnSO_4$.

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