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Effect of Manures, Fertilizers and Biofertilizers on Yield, Nutrient Content and Uptake by Ridge Gourd in Coastal Region of Maharashtra

PRANALI RATHOD, V. G. SALVI* and R. V. DHOPAVKAR

Department of Soil Science and Agriculture Chemistry,

College of Agriculture, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli - 415 712, Maharashtra

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A field trial was conducted during Kharif season of 2016 at Central Experiment Station, Wakawali to study the effect of integrated nutrient management on yield, dry matter, nutrient content as well as nutrient uptake by ridge gourd cv. Konkan Harita in coastal region of Maharashtra. The results of the experiment showed that the yield, dry matter of plant and major nutrients i.e. N, P, K, secondary nutrients i.e. Ca, Mg, S in plant increased with integrated use of manures, fertilizers and biofertilizer. Among the various treatments, the treatment receiving an integration of manure, fertilizers and biofertilizer viz. 50 per cent recommended dose of nitrogen (RDN) + 50 % N through poultry manure + P and K + Azotobacter @ 250 g 10 kg^{-1} seed recorded significantly highest yield (16.64 t ha^{-1}), dry matter (14.89 q ha^{-1}) content and nutrient content of N (1.53 %), P (0.17 %) and K (2.40 %), as well as N (30.33 kg ha^{-1}), K (3.37 kg ha^{-1}) and K (47.40 kg ha^{-1}) uptake by ridge gourd plant.

***(Key words:** Lateritic soil, Integrated nutrient management, Dry matter, Ridge gourd yield)*

Ridge gourd (*Luffa acutangula* L.) is one of the most important cucurbitaceous vegetable crop which belong to genus Luffa. It is not only importance in human diet but also helps in improving economic condition of farmers. India ranks second in vegetable production, after China. The area under Maharashtra is about 1549 ha producing about 13457.9 t of vegetables with a productivity of 8.6 t ha^{-1} (Anonymous, 2015). In Konkan region, production of vegetables is about 45,853 t having a productivity of around 10.67 t ha^{-1} (Anonymous, 2013). The chemical constituents of ridge gourd fruits include carbohydrates, carotene, fat, protein, phytin, flavonoids, saponin and amino acids. Kandlakunta *et. al*. (2008) reported that ridge gourd contains about 300 µg β-carotene and 1000 µg carotenoids per 100 g of fresh fruits.

It has various pharmacological properties like hepatoprotective, antidiabetic, antioxidant, abortifacient and antifungal activity. Ridge gourd is an excellent blood purifier; possessing laxative properties, cure for jaundice, aiding weight loss, antiinflammatory and antibiotic, fortifying the immune system, skin cure and good for stomach (Karmakar *et al*., 2013).

Ever increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production. Use of organic manures to meet the requirement of crop would be an inevitable practice in years to come for sustainable agriculture (Vennila and Jayanthi, 2008). Integrated nutrient management involves the combined use of chemical fertilizers, organic manure and biofertilizer which ensures higher crop production, helps to restore and sustain the soil fertility. Though, the lateritic soils are best suited for ridge gourd cultivation, the traditional methods of farming and less use of organic manures reduces the magnitude and quality of ridge gourd. Therefore, the present investigation was undertaken to study the effect of integrated nutrient management on yield, dry matter production, nutrient content and uptake by ridge gourd in lateritic soil of Konkan region.

MATERIALS AND METHODS

An experiment was conducted during *Kharif*, 2016 at Central Experiment Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Wakawali situated in the tropical region between 17°40′ to 17°45′ N latitude and 73°16′ to 73°19′ E longitude. The altitude varies from 167 to 234 m above mean sea level. The soil was sandy clay loam in texture (62.12, 15.19 and 22.69 per cent sand, silt and clay, respectively), moderately acidic in reaction (pH 5.53), having low electrical conductivity (0.257 dS m^{-1}) and very high soil organic carbon content (13.89 g kg^{-1}). As far as the status of major nutrients is concerned, the soil had medium

**Corresponding author:* E-mail: vgs1112@rediffmail.com

available nitrogen (316.73 kg ha^{-1}), very low available phosphorus content (9.33 kg ha^{-1}) and moderately high content of available potassium (228.48 kg ha^{-1}).

The experiment was conducted in randomized block design with eight treatments which were replicated thrice. Ridge gourd variety Konkan Harita was used for the study as the test crop. The treatments were T_1 - Absolute control, T_2 - RDF (recommended dose of fertilizer; 100:50:50 kg ha^{-1} N: P_2O_5: K_2O kg ha^{-1}), T_3 - 75 per cent RDN (recommended dose of nitrogen) + 25 per cent N through farm yard manure (FYM) + P and K + Azotobacter @ 250 g 10 kg^{-1}, T_4 – 75 per cent RDN + 25 per cent N through vermicompost + P and K+ *Azotobacter* @ 250 g 10 kg-1, T_5 – 75 per cent RDN + 25 per cent N through poultry manure + P and K+ *Azotobacter* @ 250 g 10 kg^{-1}, T_6 – 50 per cent RDN + 50 per cent N through FYM + P and K + Azotobacter @ 250 g 10 kg-1,T_7 - 50 per cent RDN + 50 per cent N through vermicompost + P and K+ *Azotobacter* @ 250 g 10 kg^{-1} and T_8 - 50 per cent RDN + 50 per cent N through poultry manure + P and K+ *Azotobacter* @ 250 g 10 kg^{-1} seed. The field was thoroughly prepared and the full doses of single super phosphate and muriate of potash were applied at the time of sowing. Nitrogen in the form of urea was applied in the three splits *i.e*. 50 per cent dose at sowing, 25 per cent at 30 DAS (at flowering stage) and the remaining 25 per cent at 60 DAS (at fruiting stage). A native strain of *Azotobacter chroococcum* collected from Department of Plant Pathology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli was use as the biofertilizer. For seed treatment with *Azotobacter*, jaggery solution was prepared by mixing 120 g gur in 1 L of water, boiled for half an hour and cooled to room temperature. Carrier based biofertilizer of *Azotobacter* @ 250 g 10 kg-1 of seed was transferred to cool jaggery solution to make a slurry. The seeds were thoroughly mixed with culture slurry so as to obtain a uniform coating of culture on the seeds. The seeds thus inoculated were spread on the clean gunny bag in shade for drying. These dried seeds were used for sowing. Farm yard manure containing 0.47% N, 0.15% P and 0.39% K, respectively vermicompost having 1.06% N, 0.59% P and 0.87% K and poultry manure with 2.38% N, 0.39% P and 0.92% K content were applied as per treatment schedule. The observation regarding the yield attributing characters, fruit yield and dry matter production were recorded from five representative plants from each plot. The ridge gourd fruits were harvested at 10-15 days interval. Fresh weight of ridge gourd fruits was calculated on the basis of yield per plot and the fruit yield was expressed in the tonnes ha^{-1}. The freshly harvested five plant samples were randomly selected from each treatment and were dried in an oven at the temperature of 60°C, grinded with grinding machine and used for determination of nutrient content in ridge gourd fruit and plant. The total N, P and K content estimated by micro-Kjeldahl method, vanado-molybdate yellow colour method and flame photometry method, respectively and were presented in per cent (Tandon, 1993). Secondary nutrient *i.e*. total calcium and magnesium were estimated by versanate titration method (Chopra and Kanwar, 1978) and expressed in per cent. Total sulphur content was estimated by turbidimetric method (Chesnin and Yien, 1950).

RESULTS AND DISCUSSION

Yield

As far as the fruit yield (Table 1) of ridge gourd was concerned, it differed significantly between the treatments and varied from 9.39 to 16.64 t ha^{-1} with a mean value of 13.59 t ha^{-1}. Among the various treatments, T_8 consisting of application of 50 per cent RDN + 50 per cent N through poultry manure + P and K + Azotobacter @ 250 g 10 kg^{-1} seed produced significantly higher fruit yield (16.64 t ha^{-1}) of ridge gourd as compared to all other treatments including absolute control (T_1) and RDF alone (T_2). However, it was at par with treatment T_7 consisting of 50 per cent RDN + 50 per cent N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed. This suggests that the application 50 per cent N through poultry manure can be substituted with vermicompost. It was also observed that the treatment T_8 and T_7 produced 11.98 and 9.29 per cent more fruit yield of ridge gourd over T_2 treatment *i.e*. application of recommended dose of fertilizer (100:50:50 kg N: P_2O_5 : K_2O kg ha^{-1}). The greater number of fruits per plant and fruit yield per plant ultimately contributed to more fruit yield per hectare. These results clearly indicated that only inorganic sources cannot maintain productivity and sustain crop yield (Salvi *et al*., 2014). There is a need

Table 1. *Effect of integrated nutrient management on yield and dry matter production of ridge gourd*

Tr. No.	Treatments	Weight of fruit per plot (kg)	Yield (t ha^{-1})	Dry matter yield of fruit (t ha^{-1})	Stover yield (t ha^{-1})
T_1	Absolute control	11.27	9.39	0.57	1.24
T_2	Recommended dose of fertilizer (100:50:50 N:P_2O_5:K_2O kg ha^{-1})	17.84	14.86	1.15	1.77
T_3	75 % RDN + 25% N through FYM + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	13.50	11.24	0.62	1.46
T_4	75 % RDN + 25% N through vermicompost+ P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	16.98	14.15	0.24	1.56
T_5	75 % RDN + 25% N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	17.40	14.48	1.43	1.86
T_6	50 % RDN + 50 % N through FYM+ P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	14.10	11.74	0.84	1.67
T_7	50 % RDN + 50 % N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	19.49	16.24	1.47	1.97
T_8	50 % RDN + 50 % N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	19.96	16.64	1.49	1.98
	Mean	16.32	13.59	1.05	1.69
	S.E.±	0.330	0.273	0.253	0.160
	C.D. (P=0.05)	1.000	0.828	0.768	0.484

to use organic, chemical fertilizer and bio-fertilizers in combination so as to increase crop productivity. The increase in the fruit yield (12.86 t ha^{-1}) due to application of RDF + $ZnSO_4$ (25 kg ha^{-1}) + Borax (5 kg ha^{-1}) + FYM (10 t ha^{-1}) + *Azospirillum* (2 kg ha^{-1}) was reported by Salvi *et al*. (2014) in okra. These results are also in conformity with those of Shinde *et al*. (2010) and Salvi *et al*. (2015), who reported increase in yield (11.4 t ha^{-1}) of okra.

Dry matter production

The data in respect of the dry matter production presented in Table 1 indicated that the dry matter production of ridge gourd ranged from 0.57 to 1.49 t ha^{-1} with a mean value of 1.05 t ha^{-1}. The highest fruit dry matter (1.49 t ha^{-1}) was recorded with the treatment T_8 consisting 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg of seed and it was significantly superior over all other treatments except treatment T_7 receiving 50 per cent RDN + 50 per cent N through vermicompost + P and K + *Azotobacter* (1.47 t ha^{-1}) and treatment T_5 *i.e*. 75 per cent RDN + 25 per cent N through poultry manure + P and K + Azotobacter (1.43 t ha^{-1}) which were found to be at par with each other. The increased dry matter production might be due to increased plant height (435.56 cm), number of branches (13.67) and leaves (89.73). The minimum fruit dry matter (0.57 t ha^{-1}) of ridge gourd was recorded in the absolute control treatment.

The stover yield of ridge gourd varied significantly from 1.24 to 1.98 t ha^{-1} with a mean value 1.69 t ha^{-1}. The highest stover yield (1.98 t ha^{-1}) was recorded with the treatment T_8 *i.e*. 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed, which was found to be significantly superior over all other treatments except treatment T_7 receiving 50 per cent RDN + 50 per cent N through vermicompost + P and K + *Azotobacter* (1.97 t ha^{-1}). The absolute control treatment recorded the minimum stover yield (1.24 t ha^{-1}). Similar results were also reported by Salvi *et al*. (2014) in okra, Thriveni *et al*. (2015) in bitter gourd and Kapse (2016) in chilli.

Nutrient content in fruit

The data pertaining to the effect of different treatments on the nutrients content in ridge gourd fruit are presented in Table 2. The maximum nitrogen (2.12 %), phosphorus (0.20 %), and potassium (3.22 %) contents were recorded with treatment T_8 consisting of 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed which was significantly higher over all other treatments. However, treatment T_7 consisting of 50 per cent RDN + 50 per cent N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed was at par with the treatment T_8 in respect of total phosphorus (0.19%) and potassium (3.15%) content. The maximum content of secondary nutrients *i.e*. calcium (0.77 %), magnesium (0.77%) and sulphur content (0.40 %) was observed in treatment T_8 receiving 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1}. However, treatment T_7 was at par with T_8 treatment in respect of total calcium (0.70%) and sulphur (0.38%) content. These results are in agreement with the findings of Shinde *et al*. (2010) who reported maximum nitrogen (2.89%), phosphorus (0.68 %) and potassium (3.58 %) in okra fruit due to integrated use of manures and fertilizers.

Nutrient content in leaf

In respect of the major nutrients presented in Table 2, significantly highest nitrogen (1.53 %), phosphorus (0.17%) and potassium contents (2.40 %) were recorded in the treatment T_8 receiving 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1}. However, treatment T8 was at par with T_7 in respect of major nutrients i.e. nitrogen (1.43%) and phosphorus (0.16%) content. The effect of integrated use of manure, fertilizer and biofertilizer on content of secondary nutrients in ridge gourd plant indicated that the total calcium (1.08%), magnesium (0.80%) and sulphur content (0.43%) were significantly higher in treatment T_8 consisting of 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1}. It was closely followed by treatment T_7 regarding calcium content. These results are in close conformity with those results reported by Shinde *et al*. (2010) who reported maximum nitrogen (1.57 %), phosphorus (0.19 %) and potassium (2.38%) in okra plant. Ghayal (2016) also reported highest nitrogen (1.66 %), phosphorus (0.31 %) and potassium (1.87 %) in cucumber.

Nutrient uptake by ridge gourd plant

The higher uptake of major nutrients i.e. N, P, K, and secondary nutrients i.e. Ca, Mg, and S (Table 3) was observed in treatment T8 receiving 50 per cent RDN + 50 per cent N through poultry manure + P and K + Azotobacter @ 250 g 10 kg^{-1} seed as compared to rest of the treatments. The maximum N uptake (61.81 kg ha^{-1}) was recorded with treatment T_8. These results are in conformity with that of Shinde *et al*., (2010) who reported maximum nitrogen (25.50 kg ha^{-1}), phosphorus (3.09 kg ha^{-1}) and potassium (38.67 kg ha^{-1}) uptake with integrated use of organic and inorganic nutrient sources. The P and K uptake by ridge gourd crop was significantly superior under T_8 treatment as compared to all other treatments. More *et al*., (2015) also observed significantly highest uptake of P and K in finger millet with increasing levels and status of phosphorus in lateritic soil of Konkan region. The maximum Mg and S was recorded with the treatment T_8, which was significantly superior over rest of the treatment, but in case of Ca uptake, it was at par with T_7 and T_5 treatments. The maximum calcium uptake due to application of inorganic, organic and biofertilizer was also reported by Parte (2013), Salvi *et al*. (2014) and Dodake *et al*. (2015) in bitter gourd. The results demonstrated the superiority of application of inorganic fertilizers in conjunction with organic manure over the use of inorganic fertilizers alone indicating the need of integrated use of organic sources of nutrients with inorganic sources.

On the basis of the results obtained during present investigation, it can be concluded that integrated use of 50 per cent RDN + 50 per cent N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1}seed is essential for improving yield, dry matter, nutrient content and uptake of ridge gourd plant grown in lateritic soil. Besides, in place of poultry manure, vermicompost can also be used as an alternate source of nutrient.

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Table 2. *Effect of integrated nutrient management on nutrient content in ridge ground fruit and plant*

Tr. No.	Treatments	Nutrient content (%)											
		Major Nutrients						Secondary Nutrients					
		N		P		K		Ca		Mg		S	
		Fruit	Plant	Fruit	Plant	Fruit	Plant	Fruit	Plant	Fruit	Plant	Fruit	Plant
T_1	Absolute control	1.13	0.82	0.12	0.09	2.14	1.32	0.20	1.00	0.38	0.44	0.18	0.21
T_2	Recommended dose of fertilizer (100:50:50 N:P_2O_5:K_2O kg ha^{-1})	2.04	1.21	0.15	0.14	2.84	1.59	0.43	1.05	0.50	0.56	0.20	0.23
T_3	75 % RDN + 25 % N through + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.00	1.10	0.13	0.10	2.38	1.44	0.23	1.02	0.41	0.41	0.25	0.26
T_4	75 % RDN + 25 % N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.02	1.30	0.14	0.12	2.92	1.63	0.27	1.03	0.46	0.45	0.27	0.27
T_5	75 % RDN + 25% N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.07	1.38	0.16	0.13	2.94	1.78	0.60	1.04	0.52	0.57	0.30	0.29
T_6	50 % RDN + 50 % N through FYM+ P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.06	1.26	0.18	0.15	3.05	1.92	0.37	1.05	0.60	0.65	0.33	0.35
T_7	50 % RDN + 50 % N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.10	1.43	0.19	0.16	3.15	2.27	0.70	1.07	0.51	0.59	0.38	0.40
T_8	50 % RDN + 50 % N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	2.12	1.53	0.20	0.17	3.22	2.40	0.77	1.08	0.77	0.80	0.40	0.43
	Mean	1.94	1.25	0.16	0.13	2.83	1.79	0.45	1.04	0.52	0.56	0.29	0.31
	S.E.±	0.004	0.035	0.003	0.004	0.026	0.030	0.027	0.007	0.008	0.020	0.006	0.004
	C.D. (P=0.05)	0.013	0.105	0.010	0.012	0.078	0.090	0.081	0.021	0.024	0.061	0.020	0.011

Table 3: *Effect of integrated nutrient management on nutrient uptake by ridge ground*

Tr. No.	Treatments	Nutrient uptake (kg ha^{-1})					
		Major Nutrients			Secondary Nutrients		
		N	P	K	Ca	Mg	S
T_1	Absolute control	16.66	1.81	28.65	13.36	7.67	3.56
T_2	Recommended dose of fertilizer (100:50:50 N:P_2O_5:K_2O kg ha^{-1})	44.91	4.12	60.93	23.51	15.57	6.34
T_3	75 % RDN + 25 % N through + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	28.59	2.21	36.27	16.37	8.77	5.41
T_4	75 % RDN + 25 % N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	37.26	3.10	50.12	18.27	10.89	6.52
T_5	75 % RDN + 25% N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	55.29	4.72	74.91	28.02	18.16	9.70
T_6	50 % RDN + 50 % N through FYM+ P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	38.36	3.97	57.70	20.45	15.93	8.52
T_7	50 % RDN + 50 % N through vermicompost + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	59.00	5.82	90.50	31.19	19.09	13.56
T_8	50 % RDN + 50 % N through poultry manure + P and K + *Azotobacter* @ 250 g 10 kg^{-1} seed	61.81	6.25	95.34	32.72	28.56	14.35
	Mean	42.74	4.00	61.80	23.40	15.58	8.50
	S.E.±	1.028	0.104	1.084	1.633	0.593	0.145
	C.D. (P=0.05)	2.267	0.316	3.289	4.954	1.593	0.439

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