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Impact of integrated nutrient management on growth and yield of Chinese potato (*Coleus rotundifolius* L.)

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Abstract
A field experiment was conducted at College of Horticulture, Venkataramannagudem, West Godavari District, Andhra Pradesh during *Rabi* 2023-24 to study the effect of Integrated Nutrient Management on growth and yield of chinese potato. The statistical design used for this experiment was Randomised Block Design (RBD) with 16 treatment combinations and replicated twice. The results revealed that the treatment combination of 75% RDN (Recommended dose of nitrogen) + 25% RDN FYM + vermicompost + biofertilizers + biochar (T_{13}) showed the highest vine length (56.00 cm), number of branches per plant (10.30), leaf area (23.50 cm^2), number of big, medium and small sized tubers (9.47, 18.16 and 41.09), total number of tubers (56.79), length of big, medium and small sized (6.79 cm, 4.39 cm and 3.79 cm), diameter of big sized (5.44 cm), medium sized (3.92 cm) and small sized tubers (1.51 cm), average weight of big sized (84.23 g), medium sized (84.23 g) and small sized tubers (26.37 g) and tuber yield (0.53 kg/plant).

Keywords: Chinese potato, FYM, vermicompost, biochar, biofertilizers and RDN

Introduction
Tropical tuber crops are known as the energy banks of nature serving either as primary or secondary staple to meet the calorie needs of about one fifth of world's population, the crops have myriad and complex roles to play in the food security, reduction of hunger and elimination of poverty (Palaniswami *et al*. 2008) [9].

Chinese potato (*Coleus rotundifolius* L.) belongs to the family Lamiaceae, chromosome number of 2n= 64, 84. It is one of the important an under utilized tuber crop with nutritional and commercial value (Murugesan *et al*. 2020) [8]. It is probably originated from Ethiopian region, now it is distributed in South-East Asia and Tropical Africa. It has several medicinal properties due to the presence of flavonoids which helps to lower the cholesterol level of blood (Kwarteng *et al*. 2018) [4], immense potential in terms of micro nutrients, phytochemicals and other phenolic compounds having good antioxidant properties (Mishra *et al*. 2022) [5].

The modern and intensive agriculture has heavy dependence on fertilizers and chemicals. The chemical fertilizers play a crucial role to meet the nutritional demands of the crop but the continuous use of chemical fertilizers is reported to have deleterious effects on soil health. Indiscriminate use of fertilizers besides increasing the production cost, also causes soil and water pollution. The use of judicious combination of organic, inorganic and biofertilizers not only improves the soil physio-chemical and biological properties, but also provides all the nutrients in available form to crop leading to enhanced growth, yield and quality.

In the present scenario, there is a need to give more emphasis on integrated nutrient management in chinese potato to get quality tubers but in south India, not much work has been done on integrated nutrient management. Hence, the present investigation was carried out under Godavari region of coastal Andhra Pradesh, to study the effect of Integrated Nutrient Management on growth and yield of chinese potato.

Materials and Methods
The present investigation was carried out at College of Horticulture, Venkataramannagudem, West Godavari District, Andhra Pradesh during *Rabi* 2023-24.

The experiment was laid out in Randomized Block Design with 16 treatments and two replications. The treatments were T_1: 100% RDF *viz*., 80:80:150 kg/ha, T_2 : 100% RDF + biofertilizers, T_3 : 100% RDF + biochar, T_4: 100% RDF + biofertilizers + biochar, T_5: 50% RDN + 50% RDN FYM, T_6: 50% RDN + 50% RDN FYM + biofertilizers, T_7: 50% RDN + 50% RDN FYM + biofertilizers + biochar, T_8: 50% RDN + 50% RDN Vermicompost, T_9: 50% RDN + 50% RDN Vermicompost + biofertilizer, T_{10}: 50% RDN + 50% RDN Vermicompost + biofertilizer + biochar, T_{11}: 75% RDN + 25% RDN FYM, T_{12}: 75% RDN + 25% RDN FYM + biofertilizer, T_{13}: 75% RDN + 25% RDN FYM + biofertilizer + biochar, T_{14}: 75% RDN + 25% RDN Vermicompost, T_{15}: 75% RDN + 25% RDN Vermicompost + biofertilizer and T_{16}: 75% RDN + 25% RDN Vermicompost + biofertilizer + biochar.

The cuttings were planted at 45x 30cm spacing during *Rabi* season. The observations were recorded at 120 days after planting from five plants in two replications. The crop was harvested at 5 months after planting. FYM, biochar (wood), vermicompost and biofertilizers *i.e*., Azospirillum, PSB and KMB were applied to the plots well before planting based on the treatment.

Plate 1: General view of chinese potato field.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

The vine length, number of leaves per plant, leaf area and number of branches per plant increased with increase in the advancement of crop age in all the treatments (Table 1 and Fig 1).

The data pertaining to vine length at 120 DAP are presented in table 1.

The maximum vine length (56.00 cm), leaf area (23.50 cm^2) and number of branches per plant (10.74) varied significantly among the different nutrient combinations, with the most notable growth observed in the treatment T_{13} that provided with 75% RDN + 25% RDN from FYM + biofertilizer + biochar followed by T_{16} with 75% RDN + 25% RDN from vermicompost + biofertilizer + biochar *viz*., vine length (53.51 cm), leaf area (21.70 cm^2) and number of branches per plant (10.30). The lowest vine length (35.51cm), leaf area (15.23 cm^2) and number of branches per plant (7.02) were recorded with the sole application of 100% RDF. Number of leaves per plant showed non significant difference among the different treatment combinations.

The increase in vegetative growth might be due to more availability of organic carbon for multiplication of micro-organism and enhanced cell elongation and multiplication due to production of growth promoting substances like vitamin-B_{12} and auxin. It helped in better uptake of nutrients and effective utilisation for the better growth. These findings are in line with the studies of Bayorbor and Gumah (2007) [2] in Frafra potato, Ravikumar. (2012) [11], in medicinal coleus, Banjare (2014) [1] in potato, Jayapal *et al*. (2015) [3] in chinese potato and Muruganandam *et al*. (2021) [7] in medicinal coleus.

The data pertaining to the yield parameters *i.e*., number of tubers per plant, tuber length (cm), tuber diameter (cm), average weight of tuber (g), tuber yield per plant (kg), tuber yield per plot (kg) and tuber yield per hectare (t) are presented in table 2.

Significant effect of INM treatments on the number of tubers per plant, tuber length (cm), tuber diameter (cm), average weight of tuber (g), tuber yield per plant (kg), tuber yield per plot (kg) and tuber yield per hectare (t) was observed maximum. Among the different treatment combinations, the highest number of big sized tubers (9.47), medium sized tubers (18.16), small sized tubers (41.09) and total number of tubers (56.79), maximum length of big sized (6.79 cm), medium sized (4.39 cm) and small sized tuber (3.79 cm), higher diameter of big sized (5.44 cm), medium sized (3.92 cm) and small sized tubers (1.51 cm), high average weight of big sized (84.23 g), medium sized (84.23 g) and small sized (26.37 g) tubers, maximum tuber yield per plant (0.53 kg), tuber yield per plot (10.28 kg) and tuber yield per hectare (25.69 t) were observed in the treatment combination of 75% RDN + 25% RDN from FYM + biofertilizer + biochar (T_{13}).

The lowest performance in yield characters *viz*., number of big sized, medium sized, small sized tubers and total number of tubers per plant (6.62, 10.85, 27.34 and 43.61) respectively, length of big, medium and small sized tubers (4.41 cm, 3.42 cm and 2.51 cm) respectively, diameter of big sized (3.84 cm), medium sized (2.50 cm) and small sized tubers (1.30 cm), average weight of big sized (68.81 g) and medium sized (32.43 g) and tuber yield (0.31 kg/plant and 16.66 t/ha) were noticed in T_1 with sole application of RDF only whereas average weight of small sized tuber (14.70 g), tuber yield per plot (6.45 kg/ha) with the combination of 100% RDF + biochar (T_3).

The higher tuber yield recorded in the present investigation with the application of organic manures (FYM, vermicompost and biochar) and biofertilizers can be attributed to mineralization and mobilization of nutrients into available forms which boost plant nutrient absorption. This might be due to available phosphorus content in soil responsible for better tuber development, humic substances present in FYM which could have mobilized the reserve food materials to the sink through increased activity of hydrolysing and oxidizing enzymes. These results are in line with the findings of Sathiyaraj. (2017) [12] in medinal coleus, Mollick *et al*. (2020) [6] in potato and Rani *et al*. (2023) [10] in chinese potato.

Table 1: Effect of Integrated Nutrient Management on vine length, number of leaves per plant, leaf area and number of branches per plant.

Treatments	Vine length (cm)	Number of leaves	Leaf area (cm^2)	No. of branches per plant
T_1	35.51	370.40	15.23	7.02
T_2	39.00	448.30	18.43	7.89
T_3	38.15	378.55	19.89	7.25
T_4	39.23	400.20	20.45	7.14
T_5	42.60	408.95	16.53	7.86
T_6	40.20	503.70	20.32	8.03
T_7	49.50	504.70	21.07	8.64
T_8	43.50	410.80	18.51	7.10
T_9	42.70	379.70	16.19	8.01
T_{10}	45.00	500.30	17.50	8.99
T_{11}	42.60	372.50	20.06	8.18
T_{12}	50.10	412.60	21.08	9.12
T_{13}	56.00	541.35	23.50	10.74
T_{14}	48.30	416.23	20.25	7.89
T_{15}	50.70	442.40	21.31	8.48
T_{16}	53.51	518.50	21.70	10.3
Mean	44.78	438.07	19.50	8.29
SEm±	0.82	37.36	0.41	0.13
CD@0.05	2.47	NS	1.23	0.39

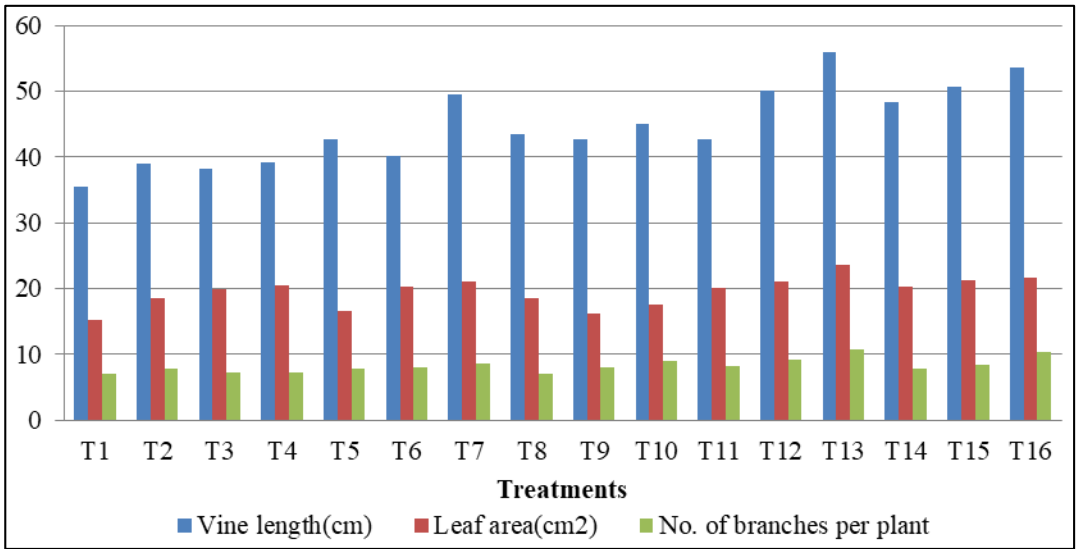

Fig 1: Effect of Integrated Nutrient Management on vine length, leaf area and number of branches per plant.

Table 2: Effect of Integrated nutrient management on yield parameters of chinese potato (*Coleus rotundifolius* L.)

No. of tubers per plant				Tuber length (cm)			Tuber diameter (cm)			Average weight of tuber (g)			Tuber yield/ plant (kg)	Tuber yield/ plot (kg)	Tuber yield/ ha (t)
	Big	Medium	Small	Big	Medium	Small	Big	Medium	Small	Big	Medium	Small			
T_1	6.62	10.85	27.34	4.41	3.42	2.51	3.84	2.50	1.3	70.23	32.43	14.74	0.31	6.67	16.66
T_2	7.30	12.44	31.42	4.71	3.61	3.27	4.12	2.65	1.32	72.43	35.24	15.73	0.33	6.93	17.32
T_3	7.17	12.20	29.67	4.59	3.50	2.73	3.92	2.53	1.29	68.81	33.56	14.7	0.32	6.45	16.84
T_4	7.30	13.70	33.98	4.81	3.65	3.17	4.35	2.74	1.36	71.77	38.21	16.135	0.33	7.09	17.71
T_5	7.02	12.66	32.80	4.96	3.70	3.11	4.52	2.83	1.40	72.50	40.69	17.515	0.36	7.36	18.40
T_6	8.59	17.05	35.72	5.43	3.91	3.24	4.76	2.92	1.44	69.14	42.24	18.515	0.35	7.51	18.79
T_7	8.90	17.60	37.33	5.89	4.08	3.5	4.92	3.62	1.48	74.14	45.73	20.735	0.39	8.24	20.60
T_8	7.70	15.38	32.12	5.31	3.84	3.69	4.25	2.95	1.37	71.43	41.81	19.23	0.38	7.96	19.89
T_9	8.10	16.80	36.40	5.22	3.93	3.69	4.20	3.36	1.40	70.26	44.75	21.575	0.39	8.25	20.39
T_{10}	8.67	17.57	38.73	5.80	4.01	3.73	4.91	3.57	1.50	78.41	48.22	24.22	0.4	8.59	21.50
T_{11}	7.90	16.17	35.01	5.40	3.81	3.20	4.69	3.01	1.43	70.33	45.11	23.07	0.41	8.73	21.83
T_{12}	9.05	17.77	38.40	6.19	4.00	3.41	4.73	3.73	1.48	80.11	49.22	24.495	0.42	8.83	22.07
T_{13}	9.47	18.16	41.09	6.78	4.39	3.79	5.44	3.92	1.51	84.23	51.80	26.37	0.53	10.28	25.69
T_{14}	8.15	17.29	35.71	5.66	3.65	3.67	4.80	3.30	1.41	73.35	47.25	21.24	0.43	8.98	22.44
T_{15}	8.70	17.54	37.22	6.13	3.92	3.50	5.01	3.70	1.49	76.34	49.85	23.73	0.46	9.41	23.55
T_{16}	9.10	18.05	40.87	6.56	4.26	3.61	5.21	3.85	1.51	81.22	50.77	25.77	0.48	9.85	24.62
SEm±	0.1	0.08	0.09	0.03	0.02	0.02	0.02	0.01	0.01	0.09	0.02	0.02	0.01	0.03	0.06
CD@0.05	0.3	0.26	0.28	0.09	0.06	0.05	0.05	0.03	0.02	0.26	0.05	0.07	0.03	0.09	0.18

(Based on tuber size: It ranged for big: 55-100g, medium: 25-55g and small: 10-25g).

Conclusion

From the present investigation it can be concluded that application of 75% RDN + 25% RDN from FYM + biofertilizer + biochar (T_{13}) followed by T_{16}: 75% RDN + 25% RDN from vermicompost + biofertilizer + biochar have showed better performance in growth and yield parameters in chinese potato. Incorporation of organic manures *i.e*., FYM, vermicompost and biochar along with biofertilizers will reduces the 25% of recommended dose of chemical fertilizers. Continuous utilization of organic manures in crop cultivation will enhance the soil fertility and soil health.

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