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Application of IoT based soil testing system for yield enhancement of gerbera

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Abstract
Soil fertility management is the key to optimising potential yield. Optimum use of soil nutrients, as well as the applied fertilizer, is ensured only by a critical soil test and crop-based site-specific application of fertilizer. Realizing the huge gap between Farmer's Fertilizer Practices and Soil test-based fertilizer application with targeted yield, a series of tests were conducted to assess the relative economic advantages of Soil test-based fertilizer. To this effect, an experiment was conducted in 20 nos. of Gerbera greenhouses in Sikkim under organic fertilization. The study lasting a year was performed under two treatments viz. Targeted Yield with soil test and crop-based fertilizer application and Farmer's Fertilizer Practice (FFP). The site and crop-specific nutrient status and requirements were determined instantly with Agrithink's IoT and AI-based Smart Soil Health Management System (SOIL CARE). The results revealed significantly better performance in the targeted yield treatment. Despite higher investment in the cost of fertilizer in this treatment, the relative income was significantly higher than FFP, which was due to the higher yield of Gerbera under site-specific crop-based fertilizer application.

Keywords: Targeted yield, crop based, gerbera, IoT, FFP, instant soil test, AI

Introduction
Gerbera (*Gerbera jamesonii* L.) is an important high-value cut flower, used as fresh and dry flowers, as aesthetic decoration, and in the making of bouquets. The gerbera cut flowers have a high demand in the domestic as well as export market (Singh *et al.* 2017a) [14]. It is a leading flower and ranks among the top ten cut flowers in the world with wider applicability in the flower industry as a cut flower and potted plant (Maitra. S. *et al*, 2020) [8]. The recent boom in the global floriculture market has necessitated technological interventions for augmenting the yield and quality of cut flowers to meet the escalating demand in the flori market. The demand for good quality cut gerbera for local as well as international trade can be successfully managed by providing the intrinsic needs of the crop through technical intervention. Growing gerbera plants under protected structures ensures year-round production of cut flowers by protecting the plants from external vagaries and providing the plants with a balanced combination of macro and micronutrients, which not only increase the cumulative yield but also enhance the quality of cut flowers in gerbera fetching higher price in the market in return (Jena l. and Pattnaik, S., 2020) [4]. Precision farming with soil test based site and crop-specific nutrient applications helps the farmers by suggesting meaningful doses in relation to crop yield and quality (Satyanarayana 2011) [13]. This investigation was laid out keeping in view, the importance of successful commercial production of Gerbera and the present-day need for real-time soil test values for crop-specific fertilizer management. The specific aim was to study the relative advantage of soil test-based site and crop-specific nutrient management over Farmer's Fertilizer Practice.

Materials and Methods
A field experiment was conducted in farmer's fields at twenty Greenhouses in Sikkim in the year 2020-2021 at MFC Namli and greenhouses belonging to progressive farmers. The study was carried out under two treatments, Farmer's Fertilizer Practice (FFP) and targeted yield system which considered soil nutrient status and nutrient requirement of *Gerbera jamesonii*. Since Sikkim is a unique and exclusively organic state in the world, the treatments received only organic manures and permitted organic fertilizer in both treatments. In both the treatments initial soil available NPK, pH, E.C. and organic carbon were analyzed. A target yield of 43.07 flowers per plant was taken for the test crop. The cropping area of each of the greenhouses was divided into two parts, one laid out under FFP and the other part kept under targeted yield

treatment. All Soil samples were analyzed in-situ using Agrithink's Smart Soil Health Management System (Soilcare) which is an instant, in-situ system of soil testing. The System is backed by IoT and AI which tests instantly all the important soil parameters given in Soil Health Card *viz*, NPK, pH, EC, Organic Carbon, Sulphur, Iron, Manganese, Copper, Zinc and Boron. Besides giving instant soil test results, the system defines nutrient requirements for different crops based on soil test values and suggests manures and fertilizer for the required crop in chemical, integrated and organic systems as per the client's need. Thus, the Nutrient requirement of NPK was also derived instantly from the Soil care system which has an in-built application to deduce Nutrient Requirements instantly under an organic, inorganic and IPN system of farming.

Initial nutrient status across the twenty greenhouses had revealed that the soils are acidic in reaction, non-saline and have low organic carbon. Available nitrogen was low in the range of 88 to 230 kg ha^{-1}, available phosphorus was low to medium with a range of 10 – 110 kg P_2O_5 ha^{-1} and available potassium was ranging from 140 – 350 kg K_2O ha^{-1} (Table1). Based on these values, the required quantity of NPK was obtained from the in-built application of Agrithink's Soilcare system which was applied in plants under targeted yield treatment.

Periodic interactions with Greenhouse owners were conducted during the experiment. Data from both treatments were recorded. In targeted yield treatment, nutrients were applied in terms of FYM, Neem cake, Dolomite, and Rich Fertiplus. In FFP farmers followed their own choice.

Yield and relative income from the two treatments were compared at the end of the year. The wholesale price of the Gerbera cut flower realized by the farmer was Rs. 6.00 per stick which was used to extrapolate the returns from the sales. The Data thus obtained, were tested statistically for significance using standard procedure and analysed accordingly.

All other operations including micronutrient application were carried out following the standard Package of Practices for Gerbera and kept uniform for both the treatments.

Table 1: Physico-Chemical Characteristics of Soil.

S. No	Farmer's Name	N (kg. ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	pH	EC (dS/m)	OC (%)
1	F1	89.00	32.00	224.00	4.6	0.04	0.33
2	F2	110.00	23.00	274.00	4.9	0.03	0.34
3	F3	180.00	53.00	154.00	5.1	0.05	0.37
4	F4	173.00	29.00	229.00	4.7	0.05	0.33
5	F5	94.00	64.00	143.00	5.4	0.04	0.51
6	F6	88.00.	72.00	179.00	5.2	0.08	0.44
7	F7	64.00	33.00	200.00	4.9	0.03	0.40
8	F8	78.00	21.00	182.00	5.4	0.02	0.42
9	F9	200.0	30.00	165.00	5.5	0.03	0.32
10	F10	198.00	26.00	228.00	5.6	0.04	0.46
11	F11	94.00	52.00	118.00	4.9	0.06	0.57
12	F12	168.00	44.00	166.00	5.2	0.04	0.52
13	F13	234.00	20.00	294.00	4.6	0.03	0.68
14	F14	176.00	25.00	320.00	5.2	0.05	0.45
15	F15	150.00	33.00	255.00	5.8	0.04	0.34
16	F16	150.00	31.00	248.00	5.8	0.05	0.54
17	F17	228.00	50.00	269.00	6.0	0.05	0.71
18	F18	91.00	47.0	236.00	5.6	0.06	0.63
19	F19	142.00	29.0	300.00	5.1	0.03	0.70
20	F20	211.00	33.0	276.00	5.2	0.04	0.71

Result and Discussion

Table 3 reveals that the vegetative characters *viz* plant height, no. of leaves and no. of suckers per plant were significantly higher in targeted yield treatment with P values less than 0.0001 in all the three characters. The vigorous growth and increase in photosynthetic surface area are very important for plant for disease resistance, well-timed attainment of the reproductive phase, ensuring good yield and quality of harvest.

Table 2: Quantity of NPK (Kg/Sq. m.) and Dolomite applied in Farmer's Fertilizer Practice and Targeted Yield.

		N (kg m^{-2})		P (kg m^{-2})		K (kg m^{-2})		Dolomite kg/Sq. mtr	
S.No	Farmer's Name	Targeted Yield	Farmer's Fertilizer Practice	Targeted Yield	Farmer's Fertilizer Practice	Targeted Yield	Farmer's Fertilizer Practice	Targeted Yield	Farmer's Fertilizer Practice
1	F1	9.836	8.30	2.188	1.60	23.599	9.00	0.417	0.146
2	F2	9.834	7.50	2.1889	1.80	23.600	8.00	0.351	0.200
3	F3	9.831	6.10	2.187	3.10	23.602	3.60	0.308	0.273
4	F4	9.831	9.20	2.189	2.00	23.599	8.00	0.395	0.100
5	F5	9.835	6.22	2.187	3.10	23.603	5.00	0.206	0.200
6	F6	9.836	6.10	2.186	3.20	23.601	9.10	0.286	0.273
7	F7	9.837	4.50	2.188	1.90	23.600	12.00	0.351	0.127
8	F8	9.836	7.20	2.189	1.90	23.601	11.40	0.242	0.373
9	F9	9.830	8.00	2.189	1.10	23.602	14.00	0.220	0.364
10	F10	9.830	7.00	2.189	1.80	23.599	12.20	0.198	0.273

11	F11	9.835	6.60	2.187	1.90	23.604	11.00	0.351	0.091
12	F12	9.832	8.40	2.188	4.00	23.602	7.00	0.286	0.091
13	F13	9.828	8.20	2.189	2.20	23.595	12.00	0.417	0.073
14	F14	9.831	7.70	2.189	4.00	23.594	6.20	0.286	0.264
15	F15	9.833	7.00	2.188	1.60	23.597	10.00	0.155	0.273
16	F16	9.833	8.00	2.188	3.00	23.598	11.00	0.155	0.291
17	F17	9.829	7.60	2.188	3.20	23.597	11.00	0.111	0.309
18	F18	9.835	7.20	2.188	3.10	23.598	6.00	0.198	0.137
19	F19	9.833	9.00	2.189	3.00	23.595	4.60	0.308	0.200
20	F20	9.829	5.50	2.189	2.00	23.596	4.00	0.286	0.237
	Mean	23.5989	8.76	2.18816	2.475	9.892	7.266	0.276	0.215
	SD	0.00287	3.10032	0.00074	0.83595	0.0062	1.1828	0.08916	0.09225
	SEM	0.00064	0.69325	0.00017	0.18692	0.0014	0.2645	0.06304	0.1029
	P value	< 0.0001		= 0.1332		< 0.0001		= 0.01924	

The yield of Gerbera for 20 greenhouses under FFP ranged from 28 to 39.33 flowers per plant per yr, with a mean yield of 32 flowers per plant per year. In the targeted yield treatment it varied from 37.4 to 46.3 flowers with a mean yield of 42.77 flowers per plant per year (Table 3). The targeted yield resulted in an additional mean yield of 10.77 flowers over FFP. Also a lower P value (<0.0001). This might be due to the application of manure based on soil nutrient supply and the need of the crop. Need-based application of NPK resulted in better assimilations of *photosynthates* (Madhavi A. *et al.* 2020) [7]. In the organic system of cultivation, there is a constant but slow release of available nutrients. So it is necessary to determine the nutrient requirement based on current soil test value as plants require a ready supply of available nutrients. Similar results were also obtained by (Ray *et al.* 2000., Meena *et al*. 2001, Jayprakash *et al*. 2006., Kumar, A. *et al*. 2007., Umesh 2008., Vikram *et al*., 2015, Kumar P. and Paramanand 2018 and Reddy, P. *et al.* 2018) [11, 9, 3, 5, 15, 12]. It was found that most of the farmers under FFP were concentrating on the application of manures and organic fertilizer inadequately on basis of availability and cost. In most of the locations, farmers following FFP could not apply balanced nutrition prescribed under Sikkim Organic Mission due to one reason or the other. It aroused an extreme concern that the Soil test value was not considered before the application of fertilizer. One of the major reasons for this was the unavailability of a precise system for instant and in-situ determination of nutrient requirements. But in treatment 2, under guided application, farmers applied balanced organic manures and fertilizer based on soil available NPK value which was determined instantly by Soilcare. There was a highly significant difference in N and K application (P<0.0001) while there was no significant difference in P application (P=0.1332). So it is evident from the result that the application of one major nutrient in an adequate quantity does not impact the overall performance. It is the use of required and balanced use of NPK that promotes yield.

Table 3: Yield attributing characters of Gerbera

		Plant Height (Cm)		Number of Leaves/Plant		Number of Suckers Per Plant	
S.No	**Farmer's Name**	**Targeted Yield**	**Farmer's Fertilizer Practice**	**Targeted Yield**	**Farmer's Fertilizer Practice**	**Targeted Yield**	**Farmer's Fertilizer Practice**
1	F1	33.20	23.60	23.00	14.80	5.28	3.33
2	F2	34.13	28.00	28.00	15.20	5.66	3.35
3	F3	29.37	28.20	24.00	23.00	4.53	3.70
4	F 4	31.10	27.00	25.60	22.00	5.40	3.53
5	F5	30.52	28.20	26.00	23.50	4.67	3.40
6	F6	33.30	22.80	25.20	25.00	4.99	3.20
7	F7	35.00	28.50	27.40	26.00	5.21	3.50
8	F8	29.50	23.40	26.10	19.30	4.60	2.80
9	F9	34.00	22.00	27.50	26.30	5.20	3.60
10	F10	32.80	26.80	25.60	20.40	5.00	3.00
11	F11	33.60	24.00	25.80	19.00	4.99	2.80
12	F12	31.00	23.90	24.90	19.40	4.80	2.80
13	F13	34.10	22.20	26.80	20.00	5.30	3.00
14	F14	30.60	25.10	24.70	20.20	5.20	3.20
15	F15	34.90	27.40	28.00	22.00	5.80	3.30
16	F16	33.20	24.40	27.50	20.40	5.77	2.90
17	F17	33.00	25.00	27.00	21.20	5.11	3.00
18	F18	31.60	25.00	25.10	21.00	5.00	2.90
19	F19	32.00	26.50	25.40	24.00	5.00	3.20
20	F20	33.00	24.80	25.80	21.30	5.20	3.00
Mean		32.446	25.3684	25.97	21.20	5.1395	3.1755
SD		1.6571	2.1497	1.342	3.022	0.352	0.2816
SEM		0.3705	0.4932	0.3	0.676	0.0808	0.063
P Value		< 0.0001		< 0.0001		< 0.0001	

One of the most important factors of crop production is pH which affects the availability of all the nutrients. In the present experiment, pH ranged from 4.6-6.0(Table1). Acidic soils create production problems by limiting the availability of

some essential plant nutrients and increasing that of the soil solution's toxic elements, such as aluminium, iron and manganese, the major cause of poor crop performance and failure in acidic soils (Das S.K and Avasthe R.K, 2018) [1]. The acidic pH of the soil was adequately ameliorated with the required quantity of Dolomite in the targeted yield treatment. The dolomite quantity was determined by the in-built application of the Soilcare System. But under FFP, soil amelioration was not done properly as was revealed during data collection. They applied some dolomite without proper measurement. This could be one of the reasons for the sub-optimal performance of Gerbera in FFP treatment.

In the experiment, an additional cost of manure and organic fertilizer of Rs 462.80/- per sq m (Table 2) was observed in treatment 2 (targeted yield) over FFP which was due to the balanced use of nutrition in the targeted yield treatment. The cost of fertilizer also showed a significant difference. Even then relative income gain between the two treatments was found to be in the range of Rs 52.93-Rs.587.68 per sq m with a mean of Rs 350.79. This was due to higher productivity and gross returns in the Targeted Yield treatment over FFP (Table4). Similar results are reported by Kumar P. and Parmanand (2018) [6] and Goswami and Nunisa (2022) [2].

Table 4: Annual yield and return from sale of cut flowers in Targeted yield and Farmer's Fertilizer Practice (FFP)

		Flowers/ Plant (Nos.)		Return from sale (Rs. / Sq. mt.)		Cost of Fertilizer (Rs./Sq. mtr.)		Net Returns (Rs./ Sq mtr)		Relative Income (Rs. / Sq. mtr.)
S. No	Farmer's Name	Targeted Yield	Farmer's Fertilizer Practice	Targeted Yield	Farmer's Fertilizer Practice	T Targeted Yield	Farmer's Fertilizer Practice	Targeted Yield	Farmer's Fertilizer Practice	
1	F1	43.20	29.22	1684.80	1139.58	133.70	60.50	1551.10	1079.08	472.02
2	F2	46.30	33.80	1805.70	1318.20	132.00	56.00	1673.70	1262.20	411.50
3	F3	44.50	36.60	1735.50	1427.40	132.55	52.00	1602.95	1375.40	227.55
4	F4	45.40	34.40	1770.60	1341.60	131.00	61.50	1639.60	1280.10	359.50
5	F5	37.40	31.20	1458.60	1216.80	134.50	53.50	1324.10	1163.30	160.80
6	F6	42.80	34.40	1669.20	1341.60	134.00	60.00	1535.20	1281.60	253.60
7	F7	43.32	36.00	1689.48	1404.00	134.50	60.00	1554.98	1344.00	210.98
8	F8	40.43	28.54	1576.77	1113.06	135.80	63.00	1440.97	1050.06	390.91
9	F9	44.70	35.80	1743.30	1396.20	132.50	65.00	1610.80	1331.20	279.60
10	F10	40.70	39.33	1587.30	1533.87	130.00	63.20	1523.60	1470.67	52.93
11	F11	39.00	28.54	1521.00	1113.06	136.60	62.50	1384.40	1050.56	333.84
12	F12	42.21	28.00	1646.19	1092.00	133.00	62.00	1513.19	1030.00	483.19
13	F13	44.22	28.66	1724.58	1117.74	128.00	64.50	1596.58	1053.24	543.34
14	F14	45.41	29.00	1770.99	1131.00	129.00	56.50	1641.99	1074.50	567.49
15	F15	47.21	30.34	1841.19	1183.26	130.50	60.25	1710.69	1123.01	587.68
16	F16	46.50	30.00	1813.50	1170.00	131.50	64.00	1682.00	1106.00	576.00
17	F17	45.66	31.11	1780.74	1213.29	128.50	63.50	1652.24	1149.79	502.45
18	F18	38.43	31.00	1498.77	1209.00	133.50	55.00	1365.27	1154.00	211.27
19	F19	38.91	33.54	1517.49	1308.06	129.50	55.50	1387.99	1252.56	135.43
20	F20	39.10	30.52	1524.90	1190.28	129.00	50.00	1395.90	1140.28	255.62
Mean		42.77	32.0000	1671.345	1248.028	131.98	59.42	1536.04	1188.5775	350.79
SD		3.0233	3.2579	117.9099	127.0715	2.5062	4.4827	118.91	127.5295	
SEM		0.676	0.7285	26.3654	28.4141	0.5604	1.0024	26.59	28.5165	
P Value		< 0.0001		<0.0001		< 0.0001		< 0.0001		

Conclusion

The comparative analysis of yield and income from gerbera cultivation under FFP and Targeted yield treatments established that Soil test-based and crop-specific management of soil fertility enhances profitability by increasing production. The farmers can be benefited by having access to real-time soil testing and crop-specific recommendation. Application of balanced fertilizer based on real-time soil test values can enhance profitability by increasing yield as per target. Though sometimes fertilizer cost under balanced application is higher, the marked increase in production has a positive impact on farmer's economic return. During this experiment, Agrithink's Smart Soil Health Management System (Soilcare) also proved to be very convenient for performing periodic soil tests. The results of the tests performed in situ were found to be reliable, accurate, in real-time, economical and time-saving compared to tedious laboratory soil testing procedures.

References

1. Das S, Avasthe RK. Managing Soil Acidity for Crop Production in Sikkim: A Policy Options. Ind. J Hill Farming. 2018;1(1):155-162.
2. Goswami B, Nunisa P. A Comparative Study on STCR based Fertilizer Application and Farmer's Fertilizer Practice (FFP) on Zea mays. J Agri and Vet. Sci. 2022;15(5):21-24. www.iosrjournals.org.
3. Jayprakash TC, Nagalikar VP, Pujari BT, Setty RA. Effect of Organics and Inorganics on Growth and Yield of Maize under Irrigation. Karnataka J Agric. Sci. 2006;18(3):798.
4. Jena L, Pattnaik S. Impact of nutrient management on yield and yield attributing traits of gerbera (*Gerbera jamesonii* L.) growing under protection. Intl. J Chem. Studies. 2020; 8: 318-323.
5. Kumar A, Gali SK, Hebsur S. Effect of Different Levels of NPK on Gowth and Yield Parameters of Sweet Corn. Karnataka J Agric. Sci. 2007;20(1):41-43.
6. Kumar P, Parmanand. Evaluation of Soil Test Crop Response Approach for Sustainable Crop Production of Rice in Baladobazar – Bhatapara District of Chhattisgarh. Intl J. Current Microbiology and Appl. Sci. 2018;Special Issue 7:3513-3518.
7. Madhavi A, Srijaya T, Surendra PB, Dey P.

Popularization of STCR Targeted Yield for Optimum Fertilizer Use and Enhanced Yields of Maize Crop through Field Level Demonstrations. Int. J Curr. Microbiol. Appl. Sci. 2020;9(8):2209-2214.
8. Maitra S, Tanmoy S, Masina S, Sandipan P. Evaluation of Gerbera (*Gerbera jamesonii* L.) Cultivars for Growth, Yield and Flower Quality under Protected Cultivation. Indian J Natural Sci. 2020;10(60):20271-20276.
9. Meena M, Ahmed S, Riazuddin M, Chandrasekhara KR, Rao BRCP. Soil Test Crop Response Calibration Studies on Onion (Allium cepa) in Alfisols. J Indian Soc. Soil Sci. 2001;49:709-713.
10. Ramamoorthy B, Narsimhan RL, Dinesh RS. Fertilizer Application for Specific Yield Targets of Sonora-64(wheat). Indian Farming. 1967;25(5):43-45.
11. Ray PK, Jana AK, Maitra DN, Saha MN, Chaudhury J, Saha S, *et al*. Fertilizer Prescription for Soil Test Basis for Jute, Rice and Wheat in Typic Ustrochept. Journal of Indian Society of Soil Science. 2000;48:79-84.
12. Reddy Prabhakar T, Madhavi A, Srijaya T, Vijayalakshmi D. Field Validation of Soil Test and Yield Target Based Fertilizer Prescription Equation for Soybean on Vertisol. J Pharmacognosy and Phytochemistry. 2018;7(6):1159-1162.
13. Satyanarayana T, Majumdar K, Biradar DP. New Approaches and Tools for Site-Specific Nutrient Management With Reference To Potassium. Karnataka J. Agric. Sci. 2011;24(1):86-90.
14. Singh P, Bhardwaj A, Kumar R, Singh D. Evaluation of Gerbera Varieties for Yield and Quality under Protected Environment Conditions in Bihar, Int. J Curr. Microbiol. App. Sci. 2017;6(9):112-116.
15. Umesh MR. Investigation on Balanced Fertilization for Maize-Pigeonpea Cropping Sequence in Alfisols of Karnataka. Ph.D. Thesis. Univ. Agric. Sci., Bangalore, 2008.
16. Vikram AP, Birdar DP, Umesh MR, Basavanneppa MA, Narayana RK. Effect of Nutrient Management Techniques on Growth, Yield and Economics of Hybrid Maize (*Zea mays* L.) in Vertisols. Karnataka J Agric. Sci. 2015;28(4):477-481.