



Impact of integrated nutrient management on floral and commercial yield characters of strawberry (*Fragaria × ananassa* Duch.)

Bijendra K. Singh*, Akhilesh K. Pal, Anil K. Singh, Akhilendra Verma and Arun Kumar

Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi- , India

*e-mail: simpalbk1987@gmail.com

(Received: August 12, 2015; Revised received: February 04, 2016; Accepted: February 09, 2016)

Abstract: A field study was conducted on Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. During 2003-14 and 2014-15. The present investigation was under taken entitled "Impact of Integrated Nutrient Management on Floral and Commercial Yield Characters of Strawberry (*Fragaria × ananassa* Duch.) cv. Chandler". The experiment was laid out in Randomized Block Design with twelve treatments and three replications. Maximum days to produce first flower (58.30 days), maximum number of runners (6.83) and maximum number of crowns (5.18) plant⁻¹ were reported in treatment 75% NPK + Vermi compost + *Azotobacter* + PSB, while minimum days to produce first flower (50.28), runners (3.27) and crowns (2.39) were recorded in control untreated plants. Duration of harvesting (64.06 days), number of flowers (62.01) and number of fruit set (51.73) plant⁻¹ were recorded highest in treatment 75% NPK + Vermi compost + *Azotobacter* + PSB. Fruit set percentage (83.67%) plant⁻¹ were recorded highest in treatment 75% NPK + FYM + *Azotobacter* + PSB. Days to fruit set (5.91 days) recorded were minimum in treatment 50% NPK + Town compost + *Azotobacter* + PSB, while flower all characters were found minimum in control. Maximum yield (297.03 g plant⁻¹, (3.55 kg) plot⁻¹ and (177.91 qt) ha⁻¹ was recorded in treatment 75% NPK + Vermi compost + *Azotobacter* + PSB while minimum yield was found in control. Benefit cost ratio maximum is found in 75% NPK + FYM + *Azotobacter* + PSB treatment and maximum gross income maximum was found in 75% NPK + Vermicompost + *Azotobacter* + PSB treatment.

Keywords: Fertilizers, Organic Manures, Bio-fertilizers, Yield and Benefit Cost Ratio

Introduction

Strawberry (*Fragaria × ananassa* Duch.) is one of the most delicious fruits of the world which has attained a premier position in the world fruit market as fresh fruit as well as in the processing industries (Sharma and Sharma, 2003). Initially grown in temperate zone of the country but its cultivation has now become possible in the sub-tropical zones as well as with the introduction of day neutral cultivar viz., Chandler, (Asrey and Singh, 2004). Among the various factors which contribute towards the growth and yield of strawberry, nutrition is the important aspect of crop production (Umar *et al.*, 2008). Integrated nutrient management includes the use of inorganic, organic and microbial sources of nutrients which ensure balanced nutrient proportion by enhancing nutrient response efficiency and maximizing crop productivity of desired quality. It also helps in minimizing the existing gap between the nutrient removal through continuous use of chemical fertilizers and supply through slow release of fertilizers. It is well reported that the extensive use of chemical fertilizers adversely affect the soil health and results in decreased crop productivity and quality (Macit *et al.*, 2007). Integrated nutrient management (INM) system envisages use of organic manures, green manures, bio-fertilizers along with chemical fertilizers. From the stand point of crop yield and quality, nutrient supply from both organic and inorganic sources is important. The INM helps to restore and sustain soil fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than N, P and K.

Good quality farm yard manure (FYM) is more valuable organic manure. The long term manorial studies conducted at many places have revealed the superiority of integrated nutrient supply system in sustaining crop productivity in comparison to chemical fertilizer alone (Gaur, 1991). The beneficial effect of vermicompost was first highlighted by Darwin (1881). Vermicompost contains micro site rich in available

carbon and nitrogen (Sudhakar *et al.*, 2002). Worm cast incorporated soils are also rich in water soluble P (Gratt, 1970) and contained two to three times more available nutrients than surrounding soils (Sudhakar *et al.*, 2002) which encourages better plant growth.

Materials and Methods

The present study was conducted at horticulture research farm of University. During 20013-14 and 2014-15. Runners of strawberry cv. Chandler were procured from Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, (Solani), H.P. respectively. The strawberry runners of uniform size were transplanted on ridges at a spacing of 40x30 cm in last week of October during both the year of experimentation. Strawberry was fertilized with recommended (100%) and half of the recommended doses (50%) of integrated sources of nutrients viz., NPK @ 100, 120 and 80Kg/ha, FYM @ 20 tonnes/ha, Vermicompost and Town compost @ 10 tonnes/ha, Neem cake and Poultry manure @ 5 tonnes/ha and biofertilizers (*Azotobacter* and Phosphorus Solubilising Bacteria) @ 50mL in 20 litres of water according to the treatment combination. The design of the experiment was Randomized Block Design with three replications and twelve treatment combinations as follows viz., T₀ – Control (Untreated), T₁ - 100% NPK, T₂ - 75% NPK + FYM + *Azotobacter* + PSB, T₃ - 75% NPK + Vermicompost + *Azotobacter* + PSB, T₄ - 75% NPK + Town compost + *Azotobacter* + PSB, T₅ - 75% NPK + Neem cake + *Azotobacter* + PSB, T₆ - 75% NPK + Poultry manure + *Azotobacter* + PSB, T₇ - 50% NPK + FYM + *Azotobacter* + PSB, T₈ - 50% NPK + Vermicompost + *Azotobacter* + PSB, T₉ - 50% NPK + Town compost + *Azotobacter* + PSB, T₁₀ - 50% NPK + Neem cake + *Azotobacter*+PSB, T₁₁ - 50% NPK+Poultry manure+*Azotobacter*+PSB.

The required quantity of organic manures as per treatment combination was applied at the time of land preparation. Urea was applied in two split doses before planting and flowering stages while the

full dose of phosphorus and potash was given before planting. Black polythene of 200 gauges was used as mulch material (Singh and Dwivedi, 2011). Other cultural practices like weeding, hoeing, irrigation, insect pest and disease management were done as and when required.

Observations recorded: The observations were recorded on five randomly selected plants from each treatment to assess the impact of integrated nutrient management on floral and commercial yield character in strawberry *cv.* chandler. Floral characters [Days to produce first flower, number of flowers plant⁻¹, days to fruit set, number of fruit set plant⁻¹, percent of fruit setting plant⁻¹ and duration of harvesting (days)] and yield plant⁻¹ (g), yield plot⁻¹ (kg) and yield ha⁻¹ (qt) reported by Tripathi *et al.* (2010), Singh and Singh (2009) and Kadlage *et al.* (2007) in strawberry.

Statistical analysis: The data recorded during the course of investigation was subjected to statistical analysis described by Panse and Sukhatme, (1985). The significance differences between the mean were tested against the critical difference at 5% probability level.

Results and Discussion

Floral characters: Mean data presented in table-1 clearly show that minimum number of days to produce first flower (50.28 days) was recorded in the plants which were untreated *i.e.* control with followed by 50% NPK + Poultry manure + *Azotobacter* + PSB (52.26 days) alone treated plants. However, the maximum number of days to produce first flower (58.30 days) was recorded in 75% NPK + Vermi compost + *Azotobacter* + PSB treatment. These results have got the support of the findings of Shukla *et al.* (2009), who recorded earliest flowering with NPK + PSB and NPK + *Azotobacter* treatments and Kumar *et al.* (2007) in tomato, Singh *et al.* (2008) also recorded advancement in flowering in *Calendula*. From the table-1 it is clear that maximum number of flowers (62.01) plant⁻¹ was recorded in 75% NPK + Vermi compost + *Azotobacter* + PSB treated plants followed by 75% NPK + FYM + *Azotobacter* + PSB (60.61), whereas the minimum number of flowers plant was observed in the control (41.01). Increased number of flowers might have also resulted because of increase in number of crowns per plant. Similar observations were also reported by Tripathi *et al.* (2010) in strawberry, who found that higher dose of *Azotobacter* and PSB (7 kg/ha) increased number of flowers per plant. The minimum number of days to fruit set (5.91 days) were recorded in plants treated with 50% NPK + Town compost + *Azotobacter* + PSB

followed by 50% NPK + Vermi compost + *Azotobacter* + PSB (6.69 days), whereas, the unfertilized plants (control) took maximum days (10.36 days) for fruit setting. However, no such reports are available from the literature and thus warrant further studies. From the table-1 it is obvious that number of fruit (51.73) plant⁻¹ were observed maximum when the plants treated with 75% NPK + Vermi compost + *Azotobacter* + PSB which were significantly to 75% NPK + FYM + *Azotobacter* + PSB treatment, whereas, the least number of fruit plant⁻¹ (29.79) was obtained from control. Maximum fruit set percentage (83.67%) was found in 75% NPK + FYM + *Azotobacter* + PSB followed (83.41%) in 75% NPK + Vermicompost + *Azotobacter* + PSB, whereas, minimum fruit set percentage (72.64%) in untreated *i.e.* control. These results are in conformity with the finding of Gajbhiye *et al.* (2003), who noted that increase in *Azotobacter* and PSB concentration resulted in higher fruit set in tomato.

Duration of harvesting was significantly increased with INM applications. From the table-1 maximum duration of harvesting (65.88 days) was observed when the plants were treated with 100% NPK, followed by (64.06 days) in 75% NPK + Vermi compost + *Azotobacter* + PSB treatment, whereas minimum in control (47.91 days). Similar results were also recorded by Tripathi *et al.* (2010), Singh and Singh (2009) in strawberry, who got advanced duration of harvesting (earliness) by approximately one month which obviously extended the period of harvesting.

Yield: During the present investigation it was observed from the table-2 that INM has given remarkable increase in the yield of strawberry fruits. The maximum yield (297.03 g) plant⁻¹, (3.55 kg) plot⁻¹ and (177.91 qt) ha⁻¹ was recorded in the plant treated 75% NPK + Vermi compost + *Azotobacter* + PSB followed by (289.48 g) plant⁻¹, (3.46 kg) plot⁻¹ and (173.41 qt) ha⁻¹ in 75% NPK + FYM + *Azotobacter* + PSB fertilized plants, whereas the minimum yield was recorded in control (144.05 g) plant⁻¹, (1.72 kg) plot⁻¹ and (86.16 qt) ha⁻¹. These findings are in line with the Wange *et al.* (1998) in strawberry, Kadlage *et al.* (2007) in tomato and Tripathi *et al.* (2010) in strawberry.

Benefit cost ratio: Data presented the Table-3 it is clear that during the year 2013-14. The maximum benefit: cost ratio (22.96:1) from treatment 75% NPK + FYM + *Azotobacter* + PSB, which was followed by treatment 75% NPK + Vermicompost + *Azotobacter* + PSB (21.87:1). Maximum net income was also obtained from

Table-1: Impact of Integrated Nutrient Management on floral characters of strawberry *cv.* chandler

Treatment	Days to produce first flower			Number of flowers plant ⁻¹			Days to fruit set			Number of fruit plant ⁻¹			Percentage of fruit setting plant ⁻¹			Duration of harvesting (days)		
	1 st	2 nd	Mean	1 st	2 nd	Mean	1 nd	2 st	Mean	1 st	2 nd	Mean	1 st	2 nd	Mean	1 st	2 nd	Mean
	year	year		year	year		year	year		year	year		year	year		year	year	
T ₀	50.40	50.16	50.28	40.80	41.23	41.01	10.13	10.60	10.36	29.45	30.13	29.79	72.19	73.09	72.64	47.83	48.00	47.91
T ₁	58.86	60.03	59.44	42.88	43.33	43.10	9.40	9.66	9.53	31.23	32.27	31.75	72.82	74.44	73.63	65.66	66.10	65.88
T ₂	57.33	58.30	57.81	60.44	60.79	60.61	7.46	7.63	7.54	50.51	50.93	50.72	83.56	83.78	83.67	61.06	61.76	61.41
T ₃	57.80	58.80	58.30	61.39	62.63	62.01	8.53	8.76	8.64	51.24	52.22	51.73	83.45	83.38	83.41	63.66	64.46	64.06
T ₄	54.53	55.56	55.04	57.27	57.90	57.58	6.93	7.23	7.08	46.28	47.05	46.66	80.81	81.24	81.02	60.30	59.16	59.73
T ₅	53.66	53.63	53.64	53.59	53.81	53.70	7.26	7.26	7.26	42.18	42.33	42.55	78.69	78.67	78.68	53.26	53.66	53.46
T ₆	52.73	52.90	52.81	51.09	51.13	51.11	7.20	7.40	7.30	40.16	40.51	40.33	78.62	79.25	78.93	51.50	52.33	51.91
T ₇	56.20	56.83	56.51	58.60	59.19	58.89	6.73	6.93	6.83	47.27	47.59	47.43	80.65	80.41	80.53	56.26	56.63	56.44
T ₈	56.40	56.83	56.61	59.92	60.56	60.24	6.53	6.86	6.69	49.79	50.06	49.92	83.09	82.75	82.92	58.26	60.66	59.46
T ₉	53.80	54.33	54.06	55.29	55.73	55.51	5.83	6.00	5.91	44.33	45.00	44.66	80.16	79.57	79.86	54.66	55.16	54.91
T ₁₀	52.53	52.66	52.59	48.53	49.02	48.77	7.13	7.13	7.13	37.24	37.97	37.60	76.72	78.12	77.42	50.80	51.23	51.01
T ₁₁	52.13	52.40	52.26	46.87	46.73	46.80	6.93	7.16	7.04	34.91	35.34	35.12	74.50	75.68	75.09	48.43	48.90	48.66
CD at 5%	3.341	2.105	0.734	1.483	1.707	0.543	0.616	0.699	0.204	1.399	1.163	0.449	2.097	3.002	1.141	1.566	1.341	1.232

treatment 75% NPK + Vermicompost + *Azotobacter* + PSB (3, 38, 1978.3 Rs.) followed by treatment 75% NPK + FYM + *Azotobacter* + PSB (3, 30, 9078.3 Rs.). The minimum benefit: cost ratio (11.65:1) from treatment 100% NPK and net income from control (15, 80, 200.0 Rs.). During the year 2014-15, the maximum benefit: cost ratio (23.16:1) from treatment 75% NPK + FYM + *Azotobacter* + PSB, which was followed by treatment 75% NPK + Vermicompost + *Azotobacter* + PSB (22.15:1). Maximum net income was also obtained from treatment 75% NPK + Vermicompost + *Azotobacter* + PSB (3, 42, 5378.3 Rs.) followed by treatment 75% NPK + FYM + *Azotobacter* + PSB (3, 33, 9078.3 Rs.). The minimum benefit: cost ratio (11.53:1) from treatment 100% NPK and net income from control (16, 00, 200.0 Rs.). Similar results were reported by Selvi *et al.*

Table-2: Impact of Integrated Nutrient Management on yield plant⁻¹, yield plot⁻¹ and yield ha⁻¹ of strawberry cv. chandler

Treatment	Yield plant ⁻¹ (g)			Yield plot ⁻¹ (kg)			Yield ha ⁻¹ (qt)		
	1 st year	2 nd year	Mean	1 st year	2 nd year	Mean	1 st year	2 nd year	Mean
T ₀	143.05	145.05	144.05	1.71	1.73	1.72	85.66	86.66	86.16
T ₁	151.60	150.12	150.86	1.81	1.79	1.80	90.66	89.83	90.24
T ₂	288.17	290.79	289.48	3.45	3.48	3.46	172.66	174.16	173.41
T ₃	295.41	298.66	297.03	3.53	3.58	3.55	176.83	179.00	177.91
T ₄	268.82	272.45	270.63	3.22	3.26	3.24	161.00	163.16	162.08
T ₅	197.81	199.89	198.85	2.36	2.39	2.37	118.33	119.66	118.99
T ₆	188.05	187.09	187.57	2.25	2.24	2.24	112.66	112.00	112.33
T ₇	228.75	230.02	229.38	2.74	2.75	2.74	137.00	137.83	137.41
T ₈	258.43	260.25	259.34	3.09	3.12	3.10	154.83	156.00	155.41
T ₉	220.58	222.86	221.72	2.64	2.67	2.65	132.16	133.50	132.83
T ₁₀	170.44	171.19	170.81	2.04	2.05	2.04	102.16	102.50	102.33
T ₁₁	165.39	166.52	165.95	1.98	1.99	1.98	99.00	99.66	99.33
CD at 5%	5.430	5.808	2.411	0.066	0.070	0.032	3.287	3.491	1.476

Table-3: Economics of the different treatments per hectare in Strawberry cv. Chandler

Treatment	Treatment cost	Total cost	Yield (q/ha) 2013-14	Gross Income 2013-14	Net Income 2013-14	B: C Ratio 2013-14	Yield (q/ha) 2014-15	Gross Income 2014-15	Net Income 2014-15	B: C Ratio 2014-15
T ₀	00	133000	85.66	1713200	1580200.0	11.88/1	86.66	1733200	1600200.0	12.03/1
T ₁	10295.6	143295.6	90.66	1813200	1669904.4	11.65/1	89.83	1796600	1653304.4	11.53/1
T ₂	11121.7	144121.7	172.66	3453200	3309078.3	22.96/1	174.16	3483200	3339078.3	23.16/1
T ₃	21621.7	154621.7	176.83	3536600	3381978.3	21.87/1	179.00	3580000	3425378.3	22.15/1
T ₄	10371.7	143371.7	161.00	3220000	3076628.3	21.45/1	163.16	3263200	3119828.3	21.76/1
T ₅	16621.7	149621.7	118.33	2366600	2216978.3	14.81/1	119.66	2393200	2243578.3	14.99/1
T ₆	10371.7	143371.7	112.66	2253200	2109828.3	14.71/1	112.00	2240000	2096628.3	14.62/1
T ₇	10547.8	143547.8	137.00	2740000	2596452.2	18.08/1	137.83	2756600	2613052.2	18.20/1
T ₈	31547.8	164547.8	154.83	3096600	2932052.2	17.81/1	156.00	3120000	2955452.2	17.96/1
T ₉	9047.8	141047.8	132.16	2643200	2502152.2	17.73/1	133.50	2670000	2528952.2	17.92/1
T ₁₀	21547.8	154547.8	102.16	2043200	1888652.2	12.22/1	102.50	2050000	1895452.2	12.26/1
T ₁₁	9047.8	142047.8	99.00	1980000	1837952.2	12.93/1	99.66	1993200	1851152.2	13.03/1

(2000); Prabhu *et al.* (2002); Srivastava *et al.* (2009), and Bairwa *et al.* (2009).

References

- Asrey, R. and Singh, R.: Evaluation of strawberry varieties under semi-arid irrigated region of Punjab. *I. J. of Hort.*, **61**: 122-124 (2004).
- Bairwa, H.L., Mahawer, L.N., Shukla, A.K., Kaushik, R. A. and Mathur, S.R.: Response of integrated nutrient management on growth, yield and quality of okra. *Indian J. Agril. Sci.*, **79**: 381-384 (2009).
- Darwin, C.R.: The Formation of Vegetable Mould through the Action and Worms, with Observations on Their Habitats". John Murray, London, p. 326 (1881).
- Gajbhiye, R.P., Sharma, R.R. and Tewari, R.N.: Effect of bio-fertilizers on growth and yield parameters of tomato. *I. J. Hort.*, **60**: 368-371 (2003).
- Gaur, A. C.: Bulky organic manure and crop residues. In: Fertilizers organic matter recyclable wastes and biofertilizers, H. L. S., Tondon, Fertilizer Development and consultations Organization, New Delhi (1991).
- Gratt, J.D.: Earthworm Ecology. *Cultural Soils*, **10**: 107-123 (1970).
- Kadlage, A.D., Jadhav, A.B. and Raina, B.: Yield and quality of tomato fruits as influenced by biofertilizer. *Asian J. Soil Sci.*, **2**: 95-99 (2007).
- Kumar, A., Kumar, J. and Babu, R.: Effect of inorganic and biofertilizers on growth, yield and quality of tomato. *Prog. Agri.*, **7**: 151-152 (2007).
- Macit, I., Koc, A., Guler, S. and Deligoz, I.: Yield, quality and nutritional status of organically and conventionally grown strawberry cultivars. *Asian J. of Plant Sci.*, **6**: 1131-1136 (2007).
- Panase, V.G. and Sukhateme.: Statistical methods for agricultural workers. I.C.A.R., New Delhi, 4th eds., p. 109 (1985).
- Prabhu, T., Narwadkar, P.R. and Sajindranath, A.K.: Economics of integrated nutrient management in Okra. *J. Maharashtra Agril. Univ.*, **27**: 316-318 (2002).
- Selvi, D. and Perumal, R.: Effect of integrated nutrient management on yield and economic of okra in an inceptisol. *Veg. Sci.*, **27**: 207-208 (2000).
- Sharma, V.P. and Sharma, R.R.: The Strawberry. Indian Council of Agricultural Research, New Delhi, p. 166 (2003).
- Singh, A. and Singh, J.N.: Effect of biofertilizers and bioregulators on growth, yield and nutrient status of strawberry cv. Sweet Charlie. *I. J. Hort.*, **66**: 220-224 (2009).
- Singh, Y.P., Dwivedi, R., and Dwivedi, S.V.: Effect of biofertilizers and graded dose of nitrogen on growth and flower yield of calendula (*Calendula officinalis*). *Plant Arch.*, **8**: 957-958 (2008).
- Singh, N. and Dwivedi, H. Studies on the different mulches on vegetative growth of strawberry (*Fragaria × ananassa* Duch.) cv. Chandler. *Progressive Horticulture*, **43**: 134-136 (2011).
- Srivastava, B. K., Singh, M. P., Singh, S., Shashilata, Srivastava, P. and Shahi U. P.: Effect of Integrated nutrient management on the performance of the crop under brinjal-pea-okra cropping system. *Indian J. Agril. Sci.*, **79**: 91-93 (2009).
- Sudhakar, G., Christopher L. A., Rangasamy, A., Subbian, P. and Velayuthan, A.: Effect of vermicompost application on the soil properties, nutrient availability, uptake and yield of rice – A review. *Agric. Rev.*, **23**: 127-132 (2002).
- Tripathi, V.K., Kumar, N., Shukla, H.S. and Mishra, A.N.: Influence of *Azotobacter*, *Azospirillum* and PSB on growth, yield and quality of strawberry cv. chandler. *Abst: National Symposium on Conservation Hort.*, Dehradun, p. 198-199 (2010).
- Umar, I., Vinod, K.W., Ravi, K., Mahital, J.: Effect of FYM, Urea and *Azotobacter* on growth, yield and quality of strawberry cv. chandler. *Not. Bot. Hort. Agrobot. Cluj.*, **37**: 139-143 (2008).
- Wange, S.S., Patil, M.T. and Singh, B.R.: Cultivar biofertilizer interaction study in strawberry. *Recent Hort.*, **4**: 43-49 (1998).