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Effect of integrated nutrient management on growth and physiological parameters of strawberry (*Fragaria* x *ananassa* Duch) under naturally-ventilated polyhouse

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ABSTRACT

Investigations were carried out at the College of Horticulture, Mudigere, Karnataka during 2014-2015 to study the effect of integrated nutrient management on growth and physiological parameters of strawberry (*Fragaria* x *ananassa* Duch) under naturally-ventilated polyhouse condition. The experiment was laid out in randomized complete block design with ten treatments replicated thrice. The strawberry plants supplied with NPK 60:30:30 or 80:40:40 kg/ha along with *Azospirillum* and phosphate solubilizing bacteria (PSB) exhibited maximum plant height; number, length and breadth of trifoliate leaves; plant spread and runners per plant. At any growth stage of the crop these treatments recorded higher dry weight (24-26 g/plant), physiological parameters such as absolute growth rate, crop growth rate, net assimilation rate, leaf chlorophyll content and per plant yield (299-305 g). Hence application of 60:30:30 kg/ha NPK along with *Azospirillum* and PSB proved beneficial for realizing higher yields.

Keywords: *Azospirillum*; NPK; PSB; growth; integrated nutrient management; strawberry

INTRODUCTION

Strawberry (*Fragaria* x *ananassa* Duch) is one of the most delicious fruits of the world which attained a prime position in the world fruit market as fresh fruit and in the processing industries (Sharma and Sharma 2003). All the cultivated varieties of strawberry are octaploid (2n= 56) in nature and belong to the family Rosaceae. Initially strawberry was grown in temperate zone of the country. However it can also be cultivated under subtropical climate stretched even to higher altitudes of tropical climate. Among the various factors which contribute towards the growth and yield of strawberry, nutrition management is the most important (Umar et al 2009). Strawberry plants are having shallow adventious roots of which 50-90 per cent are confined to upper 15 cm of the soil profile. The plant is surface-feeder and very sensitive to nutrient and soil moisture fluctuations. Although inorganic source of the fertilization is very important for the healthy growth and development of the plant supply of organic and microbial sources of nutrients have an added advantage of consistent and slow release of nutrients maintaining ideal C:N ratio and improving water holding capacity and microbial biomass of soil profile without having any residual effects. Thus an attempt has been made to assess the effect of integrated nutrient management with an emphasis on biofertilizers on performance of strawberry under naturally-ventilated polyhouse condition.

MATERIAL and METHODS

The present study was conducted in naturally-ventilated polyhouse at the College of Horticulture, Mudigere, Karnataka during 2014-2015. A total of ten treatments were replicated three times in randomized complete block design having plot size of 1.8 x 0.9 m accommodating 18 plants per plot at a spacing of 30 x 30 cm. The ten treatment combinations were T_1 [Control, 100% recommended dose of fertilizers (RDF)], T_2 (100% RDF + *Azospirillum*), T_3 [100%

RDF + phosphate solubilizing bacteria (PSB)], T_4 (100% RDF + *Azospirillum* + PSB), T_5 (75% RDF + *Azospirillum*), T_6 (75% RDF + PSB), T_7 (75% RDF + *Azospirillum* + PSB), T_8 (50% RDF + *Azospirillum*), T_9 (50% RDF + PSB) and T_{10} (50% RDF + *Azospirillum* + PSB). The strawberry variety Sujatha was used for experimentation. The one year old runners of uniform size were transplanted on raised beds in the month of September 2014. All treatments received same level of FYM @ 20 tonnes/ha. Well decomposed FYM was applied 21 days before planting; 50 per cent of nitrogen and full dose of phosphorus and potassium were applied as basal while remaining 50 per cent of nitrogen was applied at the time of flower initiation. Biofertilizers were procured from Department of Microbiology, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka. The respective biofertilizers at 5 kg/ha were mixed with part of originl quantity of FYM ten days prior to field application to enable multiplication of microorganisms and applied to that treatment. The recommended dose of NPK was applied in the form of urea, rock phosphate and muriate of potash respectively. The raised beds were completely mulched with dried paddy straw.

Observations on growth parameters were recorded at 30, 60, 90 and 120 days after planting whereas number of runners per plant was recorded one month after final harvesting of the fruits. Leaf area, leaf area index and total dry weight were recorded at 45, 75 and 105 days after planting. Leaf area was calculated by digital leaf area meter (LAM 211), leaf area index using the formula suggested by Watson (1952), absolute growth rate (AGR) as per formula suggested by Briggs et al (1920), crop growth rate (CGR) using the formula suggested by Watson (1952) and net assimilation rate (NAR) applying the formula of Gregory (1926). Chlorophyll content of leaf was analyzed by collecting the healthy and fully mature second leaf from the centre of the plant at peak vegetative stage. Chlorophyll fractions a and b of leaf tissue were determined by using dimethyl sulfoxide (DMSO) method as suggested by Shoaf and Lium (1976).

RESULTS and DISCUSSION

Different combinations of inorganic fertilizers and biofertilizers showed significant and promotive influence on the growth characters of strawberry plants (Table 1). The least performance of different growth parameters was observed in the treatment combinations of 50 per cent RDF either with *Azospirillum* or PSB or both. Application of 75 per cent RDF in the combinations influenced growth parameters in a competing level to that of application of 100 per cent RDF with biofertilizers. The maximum growth in terms of plant height, number of trifoliate leaves per plant, length and breadth of trifoliate leaves and plant spread at 120 days after planting were observed with the application of either 75 or 100 per cent RDF along with *Azospirillum* and PSB (Table 1). The increase in these vegetative growth parameters is attributed to timely application of nutrients aided by addition of biofertilizers that might have helped in N fixation and its quick release along with native phosphorous

Table 1. Effect of integrated nutrient management on growth parameters of strawberry

Treatment	Plant height (cm) at 120 DAP	Number of trifoliate leaves at 120 DAP	Trifoliate leaf length (cm) at 120 DAP	Trifoliate leaf breadth (cm) at 120 DAP	Plant spread (cm) at 120 DAP		Number of runners/ plant
					N-S	E-W	
T_1- 100% RDF (80:40:40 kg NPK/ha)	17.13	22.73	9.56	13.73	23.50	21.33	4.07
T_2- 100% RDF + *Azospirillum*	18.09	24.68	10.86	14.66	26.46	24.16	4.33
T_3- 100% RDF + PSB	18.28	24.19	10.73	14.56	25.41	23.73	4.00
T_4- 100% RDF + *Azospirillum* + PSB	21.48	27.86	11.86	15.46	29.41	25.66	5.20
T_5- 75% RDF + *Azospirillum*	17.95	23.56	10.33	14.33	24.56	22.56	4.37
T_6- 75% RDF + PSB	17.04	23.07	9.73	13.86	23.65	21.86	4.13
T_7- 75% RDF + *Azospirillum* + PSB	20.98	26.78	11.33	14.86	28.85	24.73	5.07
T_8- 50% RDF + *Azospirillum*	15.91	20.78	8.66	12.46	21.46	20.46	3.67
T_9- 50% RDF + PSB	15.45	20.35	8.23	12.23	20.95	19.73	3.27
T_{10}- 50% RDF + *Azospirillum* + PSB	16.33	21.65	9.26	13.46	22.81	20.86	4.03
SEm±	0.56	0.82	0.35	0.48	0.75	0.67	0.14
$CD_{0.05}$	1.66	1.98	1.04	1.43	2.23	2.01	0.42

DAP= Days after planting, N-S= North-South. E-W= East-West

Table 2. Effect of integrated nutrient management on yield, dry weight and chlorophyll content of leaves of strawberry

Treatment	Yield/plant (g)	Dry weight (g/plant) at harvest	Chlorophyll content (mg/g fresh weight)		
			Chlorophyll a	Chlorophyll b	Total chlorophyll
T_1- 100% RDF (80:40:40 kg NPK/ha)	184.98	18.34	1.38	0.61	1.99
T_2- 100% RDF + *Azospirillum*	231.37	22.32	1.57	0.56	2.13
T_3-100% RDF + PSB	222.42	21.84	1.53	0.58	2.11
T_4- 100% RDF + *Azospirillum* + PSB	304.73	26.44	1.73	0.62	2.35
T_5- 75% RDF + *Azospirillum*	206.03	20.44	1.46	0.59	2.05
T_6- 75% RDF + PSB	197.90	19.01	1.41	0.59	2.00
T_7- 75% RDF + *Azospirillum* + PSB	299.95	24.82	1.67	0.53	2.22
T_8- 50% RDF + *Azospirillum*	159.99	15.41	1.36	0.57	1.93
T_9- 50% RDF + PSB	154.49	14.50	1.29	0.48	1.77
T_{10}- 50% RDF + *Azospirillum* + PSB	173.30	17.01	1.34	0.49	1.83
SEm±	3.76	1.33	0.04	0.02	0.07
$CD_{0.05}$	11.16	3.95	0.11	0.07	0.22

DAP= Days after planting

Table 3. Effect of integrated nutrient management on absolute growth rate, crop growth rate and net assimilation rate at different days after planting in strawberry

Treatment	Absolute growth rate (g/plant/day) at DAP		Crop growth rate ($g/m^2/day$) at DAP		Net assimilation rate ($g/dm^2/day$) at DAP	
	45-75	75-105	45-75	75-105	45-75	75-105
T_1- 100% RDF (80:40:40 kg NPK/ha)	0.17	0.32	1.89	3.55	0. 238	0.197
T_2- 100% RDF + *Azospirillum*	0.20	0.39	2.22	4.33	0.232	0.209
T_3-100% RDF + PSB	0.19	0.38	2.10	4.22	0.230	0.207
T_4- 100% RDF + *Azospirillum* + PSB	0.28	0.46	3.11	5.11	0.238	0.183
T_5- 75% RDF + *Azospirillum*	0.18	0.36	2.00	4.00	0.226	0.207
T_6- 75% RDF + PSB	0.17	0.32	1.88	3.55	0.224	0.189
T_7- 75% RDF + *Azospirillum* + PSB	0.24	0.41	2.66	4.55	0.247	0.186
T_8- 50% RDF + *Azospirillum*	0.13	0.28	1.44	3.11	0.224	0.168
T_9- 50% RDF + PSB	0.12	0.26	1.33	2.88	0.217	0.198
T_{10}- 50% RDF + *Azospirillum* + PSB	0.15	0.30	1.66	3.33	0.228	0.200
SEm±	0.02	0.02	0.18	0.21	0.003	0.005
$CD_{0.05}$	0.05	0.05	0.52	0.61	0.015	0.017

DAP= Days after planting

solubilization for the absorption by plants leading to production of more cells and their subsequent elongation. The maximum number of runners per plant (5.20) was recorded in the treatment 100 per cent RDF + *Azospirillum* + PSB closely followed by 75 per cent RDF + *Azospirillum* + PSB (5.07). Increase in number of runners per plant might be due to the reason that increase in growth of plant in the form of height, number of leaves and leaf area which accumulated more photosynthates and thereby increased runners per plant. These results are in conformity with those of Yadav et al (2010), Nazir et al (2006) and Lata et al (2013) in strawberry.

The plants supplied with either 75 or 100 per cent RDF + *Azospirillum* + PSB recorded maximum dry weight and leaf chlorophyll content (Table 2). The increase in growth resulted in betterment of leaf area and its sustenance with time scale. Addition of biofertilizers like *Azospirillum* and PSB might have promoted release of certain growth hormones like IAA, GA_3 and cytokinin in the rhizosphere which could have caused greater cell division and cell expansion resulting in increase in leaf area (Singh and Singh 2009) and higher uptake and accumulation of greater amounts of photosynthates leading to increase in overall vegetative growth. These results are in conformity with the findings of Arancon et al (2004), Wang and Lin (2002) and Khalid et al (2013) in strawberry. The increase in computed parameters such as AGR, CGR and NAR (Table 3) at different stages could be the result of increase in the dry weight and leaf surface area induced by the combined application of inorganic fertilizers, nitrogen fixing biofertilizers and phosphate solubilizing bacteria (Kuttimani et al 2013). The variation in chlorophyll content may be due to uninterrupted supply of optimum levels of N, P and K at all stages of growth. Nitrogen is the chief constituent of chlorophyll, proteins and amino acids the synthesis of which is accelerated through increased supply of nitrogen (Kohli et al 1981). As a result of all this addition of 75 or 100 per cent RDF along with *Azospirillum* and PSB resulted in highest yield per plant (304.73 and 299.95 g/plant respectively)

Therefore it is concluded that amongst different treatments tested application of 60:40:40 kg NPK/ha along with + *Azospirillum* + PSB was more effective in improving the growth and physiological aspects of strawberry plants and yield.

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