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Effect of Integrated Nutrient Management on Yield and Quality of Strawberry (*Fragaria x ananassa* Duch.) Under Naturally Ventilated Polyhouse Condition

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ABSTRACT

Study was carried out to evaluate the effect of integrated nutrient management on yield and quality of strawberry (Fragaria x ananassa Duch.) under naturally ventilated polyhouse condition it involved ten treatments with three replications in Randomized Complete Block Design conducted at Department of Fruit Science, College of Horticulture, Mudigere, during 2014-2015. Yield components and quality parameters like per cent fruit set, number of fruits per plant, number of fruits per cluster, fruit characters, yield per plant (304.73 g plant^{-1}), non reducing sugars, total sugars, sugar to acid ratio, TSS and ascorbic acid content were found maximum under the treatment 100% RDF + Azospirillum + PSB whereas, the maximum fruit weight (15.68 g), fruit length (3.61 cm) and reducing sugars (5.02%) with moderate yield per plant (299.95 g) were recorded in the treatment 75% RDF + Azospirillum + PSB.. Application of 60:40:40 kg NPK ha^{-1} along with Azospirillum and PSB found ideal to get high yields with good quality, thereby saving 25 per cent of inorganic fertilizers.

Key words: *Azospirillum, Integrated Nutrient Management, Strawberry and Yield*

INTRODUCTION

Strawberry (*Fragaria x ananassa* Duch.), a herbaceous perennial member of Rosaceae, is a widely relished fruit owing to its flavour, deliciousness, softness and rich source of mineral and nutrients. Nutritionally, strawberry fruit contains low calorie carbohydrate, rich in vitamin A (60 IU/100 g of edible portion), vitamin C (30-120mg/100 g of edible portion), fiber with high pectin content (0.55%) available in the form of calcium pectate, which serve as an excellent ingredients for jelly making [1]. The crop is in great demand for fresh fruits as well in the processing industries, particularly for flavour purposes. Maharashtra, Punjab, Haryana, Himachal Pradesh and Uttrakhand are the major states for its cultivation.

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In order to harvest higher yields and quality fruits, use of chemical fertilizers has contributed significantly. However, continuous and indiscriminate use of chemical fertilizers caused serious damage to the soil ecosystem and physico-chemical characteristics. Although, many organic options are available but high yield and better quality fruits cannot be expected from the sole application of organic manures or biological products. Therefore, a judicious combination of inorganic and organic fertilizers along with bio-fertilizers may be helpful in increasing the fruit production in strawberry. Moreover, such efforts shall be helpful to maintain sustainable productivity and soil health. Amongst various available organic options, bio-fertilizers are agriculturally important beneficial microorganisms which have ability to mobilize the nutritionally important elements. Moreover, they are cost effective and renewable. Bio-fertilizers are known to increase the yield of strawberry [2]. In view of the above, the present investigation was undertaken to study the effect of integrated nutrient management, with an emphasis on bio-fertilizers, on yield and quality of strawberry under naturally ventilated poly house condition.

MATERIAL AND METHODS

The present study was conducted in naturally ventilated polyhouse of Fruit Science Department, College of Horticulture, Mudigere, during 2014-2015. A total of ten treatments were replicated three times in Randomized Complete Block Design having plot size 1.8 m x 0.9 m accommodating 18 plants in each plot at a spacing of 30 cm x 30 cm. The ten treatment combinations were as follows viz., T_1 - Control (100% RDF), T_2 - 100% RDF + *Azospirillum*, T_3 - 100% RDF + 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 uniform sized runners of one year old were transplanted on raised beds in the month of September 2014. The recommended dose of fertilizers and manures for strawberry are 80:40:40 kg NPK and FYM @ 20 tonnes per hectare. All treatments received same level of FYM. Well decomposed FYM was applied 21 days before planting while 50 per cent of nitrogen and full dose of phosphorus and potassium were applied as basal while remaining 50 per cent of nitrogen was made available at the time of flower initiation. Bio-fertilizers were procured from Department of Microbiology, University of Agricultural Sciences, GKVK, Bengaluru. The bio-fertilizers at the rate of 5 kg ha^{-1} were mixed with part of original quantity of FYM 10 days prior to field application to enable multiplication of micro organisms. The recommended doses of NPK were applied in the form of urea, rock phosphate and muriate of potash, respectively. After transplanting, the raised beds were completely mulched with dried paddy straw.

Observations on yield parameters like per cent fruit set, number of fruits per plant, number of fruits per cluster, fruit weight (g), fruit length (cm), fruit width (cm), fruit volume (ml) and yield per plant (g) were recorded using standard methods. The TSS was recorded with the extracted fruit juice using a digital hand refractrometer at room temperature and expressed in ^{0}Brix. The reducing sugars, non reducing sugars and total sugars were estimated using the method suggested by [3]. Ascorbic acid and Titratable acidity were determined by titration method as per the modified procedure of A.O.A.C.[4].

RESULTS AND DISCUSSION

Different INM treatments in test influenced yield parameters positively (Table 1). The strawberry plants provided with 100% RDF + *Azospirillum* + PSB produced maximum per cent fruit set (75.75), number of fruits per plant (21.47), number of fruits per cluster (6.26), fruit width (2.56 cm), fruit volume (20.39 ml) and yield per plant (304.73 g) but found stastically on par with the treatment 75% RDF + *Azospirillum* + PSB. Fruit weight

(15.68 g) and fruit length (3.61 cm) were found maximum in the treatment 75% RDF + *Azospirillum* + PSB (Table 1). The increase in per cent fruit set and number of fruits per plant with the application of either 75% or 100% RDF + *Azospirillum* + PSB might be due increased phosphorus availability through phospho bacteria and IAA from *Azospirillum* leading to increased endogenous hormonal levels in plant tissue making responsible for enhanced pollen germination and pollen tube formation ultimately helping increased fruit set and number of fruits per plant [5]. Fruit characters such as length, width, volume and weight may be attributed to better fillings of fruits due to more balanced uptake of nutrients that have led to better metabolic activities, thus led to high protein and carbohydrate synthesis[6]. The increased fruit set percentage and number of fruits per plant ultimately results in increase in yield.

Significant difference was observed between the treatments with respect to quality parameters (Table 2). The maximum reducing sugars, non reducing sugars, total sugars, total soluble solids, ascorbic acid content and sugar to acid ratio were recorded in the treatments either 75% or 100% RDF + *Azospirillum* + PSB. The increase in TSS and total sugars may be attributed to absorption of nitrogen exerted regulatory role as an important constituent of endogenous factors in affecting the quality of fruit in which carbohydrate is important and during ripening of fruits the carbohydrate reserves of the roots and stem are drawn upon heavily by fruits which might have resulted into higher TSS and sugar contents in fruits [7]. Due to increase in total sugars, sugar to acid ratio was found maximum. The current findings are in line with the findings of [6,8] and[9].

The minimum titratable acidity (0.63) was recorded in the treatment 100% RDF + *Azospirillum* + PSB which was on par with 75% RDF + *Azospirillum* + PSB (0.65). The reduction in titratable acidity may be attributed to the conversion of the organic acids and photosynthates into sugar during fruit ripening by applying biofertilizers and further utilization of acids as a substrate for respiration during ripening and neutralization of organic acids due to potassium in tissues[10].

The studies emphasize the application of 75% RDF + *Azospirillum* + PSB as best treatment in terms of better yield and quality of strawberry. It is worthy to note that using inorganic fertilizers at the rate of 75% recommended dose with bio-fertilizers and organic manure had a similar effect with that of inorganic fertilizers at the rate of 100% recommended dose with bio-fertilizers and organic manure. Hence, it could be concluded that, by using bio-fertilizer can reduce 25% of the recommended dose of inorganic fertilizer application.

Table 1: Effect of integrated nutrient management on yield parameters of strawberry

Treatments	Yield parameters							Yield per plant (g)
	Per cent fruit set	Number of fruits per plant	Number of fruits per cluster	Fruit weight (g)	Fruit volume (ml)	Fruit length (cm)	Fruit width (cm)	
T_1 - Control (100% RDF)	69.94	15.20	4.33	12.17	18.03	3.20	2.15	184.98
T_2 - 100% RDF + *Azospirillum*	71.46	16.73	5.33	13.83	18.91	3.47	2.33	231.37
T_3 - 100% RDF + PSB	70.28	15.73	5.00	14.14	18.87	3.42	2.29	222.42
T_4 - 100% RDF + *Azospirillum* + PSB	75.75	21.47	6.26	14.20	20.39	3.58	2.56	304.73
T_5 - 75% RDF + *Azospirillum*	69.14	15.33	4.86	13.44	18.66	3.26	2.24	206.03
T_6 - 75% RDF + PSB	69.15	15.20	4.56	13.02	18.45	3.21	2.18	197.90
T_7 - 75% RDF + *Azospirillum* + PSB	73.74	19.13	5.73	15.68	20.34	3.61	2.48	299.95
T_8 - 50% RDF + *Azospirillum*	65.84	13.40	3.56	11.94	17.40	3.10	2.08	159.99
T_9- 50% RDF + PSB	68.33	14.20	3.10	10.88	17.35	3.06	2.13	154.49
T_{10}- 50% RDF + *Azospirillum* + PSB	68.38	14.60	4.16	11.87	17.91	3.15	2.18	173.30
S.Em±	1.00	0.89	0.40	0.65	0.044	0.02	0.02	3.76
CD @ 5%	2.98	2.64	0.68	1.92	0.021	0.05	0.07	11.16

Table 2: Effect of integrated nutrient management on quality parameters of strawberry

Treatments	Quality parameters						
	Reducing sugars (%)	Non reducing sugars (%)	Total sugars (%)	Titratable acidity (%)	Sugar-acid ratio	TSS (^{0}Brix)	Ascorbic acid content (mg/ 100 g)
T_1 - Control (100% RDF)	4.67	1.07	5.74	0.77	7.45	6.23	50.22
T_2 - 100% RDF + *Azospirillum*	4.85	1.17	6.02	0.66	9.12	7.60	56.24
T_3 - 100% RDF + PSB	4.74	1.13	5.87	0.67	8.76	7.45	55.91
T_4 - 100% RDF + *Azospirillum* + PSB	4.95	1.40	6.35	0.63	10.07	8.45	60.51
T_5 - 75% RDF + *Azospirillum*	4.94	1.17	6.11	0.68	8.98	7.74	56.85
T_6 - 75% RDF + PSB	4.81	1.12	5.93	0.70	8.47	7.83	57.11
T_7 - 75% RDF + *Azospirillum* + PSB	5.02	1.21	6.23	0.65	9.58	8.13	59.16
T_8 - 50% RDF + *Azospirillum*	3.90	0.96	4.86	0.80	6.07	6.13	53.21
T_9- 50% RDF + PSB	4.10	0.94	5.04	0.88	5.72	6.47	53.17
T_{10}- 50% RDF + *Azospirillum* + PSB	4.58	0.98	5.56	0.75	7.41	6.26	54.17
S.Em±	0.04	0.10	0.08	0.01	0.39	0.09	0.80
CD @ 5%	0.11	0.21	0.23	0.02	0.68	0.26	2.37

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