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Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago canadensis* L.) cv. Golden Gate

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Abstract

A field experiment entitled "Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago Canadensis* L.) cv. Golden Gate was carried out on Experimental field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Science. Based on the experiment, Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago Canadensis* L.) cv. Golden Gate, it is concluded that T₆ RDF (150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹ + NC 2 t ha⁻¹ has shown the best treatment in terms of plant growth and yield of Golden Rod cv. Golden Gate. In which it has shown best plant height, plant spread (cm) in (E-W and N-S), length of the stalk, weight of the stalk, number of stalks per plant, number of days taken for 50% flowering and 100% flowering and vase life when kept in water. As far as economics concerned, application treatment found best T₆ RDF (150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹ + NC 2 t ha⁻¹ maximum net returns with maximum BCR (4.51).

Keywords: Organic, inorganic fertilizer, biofertilizer, growth, spike yield and Golden Rod

Introduction

Flowers have been an integral part of Indian culture, being used in social and religious functions, requirement of daily life or just a passion. These are also symbolize beauty, love and tranquility. Growing of flowers have been practiced in our country for many centuries as evidenced by the references found in ancient literature but commercial cultivation of flowers and development of floriculture as an industry are of recent origin (Singh and Sangama 2000)^[9].

They are used as loose flowers. But today, realizing the importance of cut flowers at national and international levels, cultivation of high value cut flower crops such as Dutch rose, carnation, gladiolus, golden rod, gypsophila, gerbera, lilium *etc.* have been under taken.

The world trade in flowers is estimated to about \$50 billion. Contribution from developed countries is higher in total world trade in floricultural products. Cut flowers contribute 45 per cent share of the total world trade in floricultural products (Singh and Sangama, 2000)^[9].

In the global market, Netherlands, Germany, Japan, Europe, U.A.E and Hong Kong are the main markets for Indian flowers. International trade of flowers has greatly expanded. *Solidago*, commonly known as golden rod, belongs to the family Asteraceae botanically known as *Solidago canadensis* L. The genus comprises about 130 species, mostly native of North America.

Few species like *Solidago canadensis*, *S. virgaurea*, *S. memorialis* are grown in beds borders or rock garden. Besides, they are also used as cut flowers for indoor decoration and bouquets. It produces large panicles of yellow flowers for several months a year, which are very attractive cut flowers. These hardy perennial herbs grown in almost all types of climates and soils but prefer a sunny location.

Golden rod (*Solidago canadensis* L.) is an ornamental plant which belongs to the family Asteraceae. The genus *Solidago* comprises about 100 species mostly native to North America. However, a few species are also found in South America, temperate Europe and Asia (Sharma, 1989).

For maximization of yield and quality of any flower crop, fertilization especially with proportion is to be properly followed. Continuous use of inorganic fertilizers has resulted in ecological imbalance with consequent ill effect on soil and environment.

To maintain long term soil health and productivity there is a need for integrated nutrient management through manures and bio-fertilizers apart from costly chemical fertilizers for better yield of the crop (Mondal *et al.* 2003) [3].

This hardy perennial produces attractive flowers for several months in a year. It is cultivated for use as cut flower all over the world, besides being grown in beds, borders, rock gardens, etc. As a cut flower and filler it could be used either singly or with other flowers in flower bouquets and other flower arrangements. Both fresh and dried bouquets can be brightened with goldenrod. Dried sprays are particularly useful in herbal wreaths and fall wall ornaments (Nathan, 1997).

Goldenrod can also be used medicinally. Native Americans made tea out of goldenrod for sore throat and fatigue. Some Europeans use goldenrod for urinary tract infections and to flush the kidneys (Smith, 2003).

Materials and Methods

The present investigation "Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago Canadensis* L.) cv. Golden Gate" was carried out at Department of Horticulture, Naini Agriculture Institute, SHUATS, Prayagraj during the Rabi season, (2020-2021).

The suckers of golden rod with uniform size which is 4 to 5 leaf stage were brought from Department of Horticulture, SHUATS, transplanting was done in the prepared raised beds on 5th November 2020 during the evening. Allahabad is situated at an elevation of 78m from sea level at 25.87 °C north latitude and 81.5 °C east longitude. Region has tropical and sub – tropical climate with extremes of summer and winter.

In winter during December to January the temperature goes down as low as 1 °C, during winter frost occurs sometimes, where as in summer specially in May – June temperature goes to 47 °C and hot scorching winds are regular feature, the average rainfall is about 102cm concentrated mostly during the monsoon (i.e. July to September with Occasional showers in winters).

The soil of the experimental site is Sand (60.60), Silt (19.20), Clay (20.20), Soil pH (7.3), EC (dsm⁻¹ at 25 °C) (0.26), Organic carbon (%) (0.46), Available nitrogen (kg ha⁻¹) (45), Available phosphorus (kg ha⁻¹) (18) and Available potash (kg ha⁻¹) (112.50).

The experiment was laid out under Randomized Block Design with 13 treatments with three replications. This experiment was laid out in Randomized Block Design consisted thirteen treatments including T₀Control, T₁FYM10 t ha⁻¹, T₂FYM 10 t ha⁻¹+ BF10 kg ha⁻¹, T₃FYM 10 t ha⁻¹+ BF10 kg ha⁻¹ + NC 2 t ha⁻¹, T₄RDF (150:100:100) + FYM 10 t ha⁻¹, T₅RDF (150:100:100) + FYM 10 t ha⁻¹ +BF 10 kg ha⁻¹, T₆RDF(150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₇75% RDF(112.5:75:75) + FYM10 t ha⁻¹ + BF10 kg ha⁻¹, T₈75% RDF(112.5:75:75) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₉50% RDF (75:50:50) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹, T₁₀50% RDF (75:50:50)+ FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₁₁65% RDF(97.5:65:65) + FYM 10 t ha⁻¹ + NC 2 t ha⁻¹ and T₁₂75% RDF(112.5:75:75) + FYM 10 t ha⁻¹+ NC 2 t ha⁻¹.

The observations on plant height (cm), plant spread (E-W), plant spread (N-S), number of stalk per plant, stock length (cm), weight of stock (gm), days for 50% flowering, days for 100% flowering, vase life when kept in water (days) and number stock ha⁻¹. Observations on vegetative, flowering and

yield were recorded and the data was analyzed as suggested by Panse and Sukhatme (1967).

Results and Discussion

The present study on the Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago Canadensis* L.) cv. Golden Gate was carried out with an objective of standardizing the most effective combination of organic, inorganic and biofertilizer for optimum growth and yield of Golden Rod at Sam Higginbottom University Of Agricultural Technology And Sciences, NAINI, The results obtained from the present research work are briefly described hereunder along with relevant discussion.

Distinctive divergences with respect to plant height (cm), plant spread (N-S), plant spread (E-W) at 120 DAT, number of stalk per plant, weight of stock (gm) and stock length (cm) were observed with different treatments. The data presented in Table (1) indicated that there was significantly altered the plant height (cm), plant spread (N-S), plant spread (E-W) at 120 DAT, number of stalk per plant, weight of stock (gm) and stock length (cm). The maximum plant height (94.75cm), plant spread (E-W) (77.99), plant spread (N-S) (81.54) at 120 DAT, number of stalk per plant (15.22), stock length (cm) (45.13) and weight of stock gm) (59.54) were observed in T₆ RDF(150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹+ NC 2 t ha⁻¹ followed by T₈ 75% RDF(112.5:75:75) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₇ 75% RDF(112.5:75:75) + FYM10 t ha⁻¹ + BF10 kg ha⁻¹ and T₉ 50% RDF (75:50:50) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹.

However, minimum plant height was recorded in T₀ (control) i.e. (49.64), plant spread (E-W) (47.84), plant spread (N-S) (50.29) at 120 DAT number of stalk per plant (4.63), stock length (34.76cm), weight of stock (gm) (43.30).

It might be attributed to the availability of three major nutrients that may led to enhanced growth as a result of increased cell division, cell enlargement and maximum conserved of photosynthesis to plant growth (Sajid and Amin, 2014) [8].

Whereas The minimum days for 50% flowering (77.25) and days for 100% flowering (93.77) were observed in T₆ RDF(150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹+ NC 2 t ha⁻¹ followed by T₈ 75% RDF(112.5:75:75) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₇ 75% RDF(112.5:75:75) + FYM10 t ha⁻¹ + BF10 kg ha⁻¹ and T₉ 50% RDF (75:50:50) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹. However, maximum days for 50% flowering and days for 100% flowering was recorded in T₀ (control) i.e. (95.89 & 120.55).

Distinctive divergences with respect to number stock ha⁻¹ were observed with different treatments. It might be due to the fact the bio-fertilizers produce the growth promoting substance and other acids like acetic, formic, propanoic, lactic, glycolic, fumaric and succinic which were positively correlated with growth, flowering and yield. It has also been reported by Kumar *et al.* (2006) [2] marigold and Syamal *et al.* (2006) [10] in marigold.

The maximum Vase life when kept in water (days) (11.40) and number stock ha⁻¹ (751429.4) were observed in T₆ RDF(150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹+ NC 2 t ha⁻¹ followed by T₈ 75% RDF(112.5:75:75) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹+ NC 2 t ha⁻¹, T₇ 75% RDF(112.5:75:75) + FYM10 t ha⁻¹ + BF10 kg ha⁻¹ and T₉ 50% RDF (75:50:50) + FYM 10 t ha⁻¹+ BF 10 kg ha⁻¹.

However, maximum Vase life when kept in water (days) and

number stock ha⁻¹ was recorded in T₀ (control) i.e. (5.79 & 228638.66). The results are in agreement with the findings of

Rathi, *et al.* (2005) ^[7]. Kumar *et al.* (2006) ^[2] and Dami Vandana *et al.* (2013) ^[1] in marigold.

Table 1: Growth Parameters

Treatment symbol	Treatment Combination	Plant height (cm)				Plant spread (E-W)				Plant spread (N-S)			
		30	60	90	120	30	60	90	120	30	60	90	120
		DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT	DAT
T ₀	Control	16.47	22.84	42.28	49.64	25.24	31.37	40.09	47.84	27.69	33.82	42.54	50.29
T ₁	FYM10 t ha ⁻¹	18.13	25.24	48.38	75.75	32.49	39.73	45.80	52.00	35.15	42.39	48.46	54.66
T ₂	FYM 10 t ha ⁻¹ + BF10 kg ha ⁻¹	18.47	27.07	54.44	75.55	30.21	40.45	52.06	60.87	32.57	42.81	54.42	63.23
T ₃	FYM 10 t ha ⁻¹ + BF10 kg ha ⁻¹ + NC 2 t ha ⁻¹	17.53	25.07	53.87	73.11	28.88	30.51	44.36	53.37	32.13	41.76	47.61	56.62
T ₄	RDF (150:100:100) + FYM 10 t ha ⁻¹	19.14	28.51	49.84	72.78	32.30	38.04	45.23	56.51	35.82	41.56	48.75	60.03
T ₅	RDF (150:100:100) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹	24.10	30.04	50.39	83.34	27.07	36.52	46.92	57.29	30.22	39.67	50.07	60.44
T ₆	RDF(150:100:100) + FYM10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	32.11	44.87	59.39	94.75	39.41	51.17	67.18	77.99	42.96	54.72	70.73	81.54
T ₇	75% RDF(112.5:75:75) + FYM10 t ha ⁻¹ + BF10 kg ha ⁻¹	27.12	37.7	57.51	90.53	37.40	48.62	62.74	73.87	40.52	51.74	65.86	76.99
T ₈	75% RDF(112.5:75:75) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	28.73	40.07	58.51	92.22	38.04	49.48	65.33	75.25	41.15	52.59	68.44	78.36
T ₉	50% RDF (75:50:50) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹	26.26	36.78	55.76	89.61	36.34	47.44	60.07	71.44	38.75	49.85	62.48	73.85
T ₁₀	50% RDF (75:50:50) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	23.53	34.78	53.30	83.37	31.50	42.01	48.74	58.63	34.16	44.67	51.40	61.29
T ₁₁	65% RDF(97.5:65:65) + FYM 10 t ha ⁻¹ + NC 2 t ha ⁻¹	22.94	34.81	53.26	83.22	35.76	44.10	47.70	57.60	37.90	46.24	49.84	59.74
T ₁₂	75% RDF(112.5:75:75) + FYM 10 t ha ⁻¹ + NC 2 t ha ⁻¹	21.47	31.57	51.97	85.04	32.38	45.13	56.45	63.53	34.49	47.24	58.56	65.64
	F-Test	S	S	S	S	S	S	S	S	S	S	S	S
	C.D.at 0.5%	2.067	2.94	3.224	4.430	1.641	2.631	5.228	2.600	1.71	2.739	5.216	2.523
	S.Ed. (+)	1.001	1.428	1.562	2.146	0.795	1.275	2.533	1.260	0.824	1.327	2.527	1.223

Table 2: Show the Floral Parameters

Treatment Symbol	Treatment Combination	Floral Parameters						
		Number of stalk per plant	Stock length (cm)	Weight of stock (gm)	Days for 50% flowering	Days for 100% flowering	Vase life when kept in water (days)	Number stock ha ⁻¹
T ₀	CONTROL	4.63	34.76	43.30	95.89	120.55	5.79	228638.66
T ₁	FYM10 t ha ⁻¹	12.44	38.41	49.33	92.59	114.25	7.67	614312.08
T ₂	FYM 10 t ha ⁻¹ + BF10 kg ha ⁻¹	12.07	38.33	54.17	87.60	109.96	7.50	596040.74
T ₃	FYM 10 t ha ⁻¹ + BF10 kg ha ⁻¹ + NC 2 t ha ⁻¹	11.38	38.56	56.09	86.60	108.04	7.48	561802.55
T ₄	RDF (150:100:100) + FYM 10 t ha ⁻¹	10.78	38.54	55.10	82.63	110.78	8.69	532502.57
T ₅	RDF (150:100:100) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹	10.51	41.32	53.15	87.71	106.26	9.75	519169.43
T ₆	RDF(150:100:100) + FYM10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	15.22	45.13	59.54	77.25	93.77	11.40	751429.43
T ₇	75% RDF(112.5:75:75) + FYM10 t ha ⁻¹ + BF10 kg ha ⁻¹	13.06	42.81	57.05	82.51	101.06	10.34	644764.31
T ₈	75% RDF(112.5:75:75) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	13.81	44.16	58.62	79.62	95.84	10.49	681965.42
T ₉	50% RDF (75:50:50) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹	12.86	43.10	55.87	83.22	103.33	9.97	635052.52
T ₁₀	50% RDF (75:50:50) + FYM 10 t ha ⁻¹ + BF 10 kg ha ⁻¹ + NC 2 t ha ⁻¹	12.45	40.32	51.78	83.92	105.47	9.08	614805.9
T ₁₁	65% RDF(97.5:65:65) + FYM 10 t ha ⁻¹ + NC 2 t ha ⁻¹	10.43	41.05	50.95	89.28	102.83	7.85	515054.26
T ₁₂	75% RDF(112.5:75:75) + FYM 10 t ha ⁻¹ + NC 2 t ha ⁻¹	11.25	38.33	49.10	88.79	116.79	7.31	555547.5
	F-Test	S	S	S	S	S	S	S
	C.D.at 0.5%	1.295	2.537	5.156	3.510	3.510	1.131	63932.296
	S.Ed. (+)	0.627	1.229	2.498	1.701	1.701	0.548	30976.520



Fig 1: Show the tree

Conclusion

Based on the present investigation Effect of organic, inorganic and biofertilizer on plant growth and spike yield of Golden Rod (*Solidago Canadensis* L.) cv. Golden Gate, it is concluded that T₆ RDF (150:100:100) + FYM10 t ha⁻¹ + BF 10 kg ha⁻¹+ NC 2 t ha⁻¹ has shown the best treatment in terms of plant growth and yield of Golden Rod cv. Golden Gate. In which it has shown best plant height, plant spread (cm) in (E-W and N-S), length of the stalk, weight of the stalk, number of stalks per plant, number of days taken for 50% flowering and 100% flowering and vase life when kept in water.

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