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RESEARCH PAPER

Effect of nitrogen, phosphorus and potassium on growth and yield of golden rod (*Solidago canadensis* L.) cv. LOCAL

A.B. SAVALIYA **AND** J.D. VALA*
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA

Abstract : An experiment was conducted to study the effect of nitrogen, phosphorus and potassium on growth and yield of golden rod (*Solidago canadensis* L.) cv. LOCAL using twelve treatment combinations consisting of three levels of nitrogen *viz.*, 150, 200 and 250 kg/ha, two levels of phosphorus *i.e.,* 100 and 150 kg/ha, two levels of potassium 50 and 100 kg/ha were tried in Randomized Block Design with factorial concept (FRBD) with three replications. The results revealed that the application of nitrogen @ 250 kg/ha, phosphorus 150 kg/ha and potassium 100 kg/ha (half dose of nitrogen and full dose of phosphorus and potash at the time of planting and remaining half dose of nitrogen at 30 days after planting) significantly increased growth parameters *viz.*, plant height, plant spread, fresh and dry weight of plant, number of suckers per plant and yield attributes like fresh and dry weight of panicles, number of panicles per plant and number of panicles per hectare.

Key Words : Golden rod, *Solidago canadensis,* Nutrients, Cut flower

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INTRODUCTION

Golden rod (*Solidago canadensis* L.) is an important flower crop at international level, basically as a filler material in floral arrangement. Golden rod is perennial flower crop cultivated for its flower stalk. It belongs to family Asteraceae. The genus Solidago comprises about 100 species, most of which native to north America, few of which are found in south America, temperate Europe and Asia. Golden rod is known as *sonasali* in local language. Few species like *S. canadensis, S. virgourea, S. memeoralis* are grown in beds, borders or rock garden. Yellow panicles, all for several months produced during a year, which are very attractive as cut flowers and also used in bouquet and table decoration purpose.

Golden rod is the flower crop with more green biomass and it expands as a ratoon crop also, hence, it requires more amounts of different nutrients. However, the exact requirement of major nutrient like N, P and K is not known.

MATERIAL AND METHODS

The present investigation was carried out at Horticulture Instructional Farm, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh on golden rod during February, 2010 to November, 2010. After detaching the suckers from mother plant immediately they were transplanted in each plot at the spacing of 30×30 cm on 2nd week of February in summer season and experiment was designed in a Randomized Block Design with factorial concept (FRBD) with three replications. The details of the treatments are Table A.

The soil samples were collected from 15 cm depth of

*** Author for correspondence**

Table A : Details of treatments, their combination and level of nutrients

Treat. No.	Treatment combinations	Level of nitrogen (kg/ha)	Level of phosphorus (kg/ha)	Level of potassium (kg/ha)
1.	$N_1P_1K_1$	150	100	50
2.	$N_1P_1K_2$	150	100	100
3.	$N_1P_2K_1$	150	150	50
4.	$N_1P_2K_2$	150	150	100
5.	$N_2P_1K_1$	200	100	50
6.	$N_2P_1K_2$	200	100	100
7.	$N_2P_2K_1$	200	150	50
8.	$N_2P_2K_2$	200	150	100
9.	$N_3P_1K_1$	250	100	50
10.	$N_3P_1K_2$	250	100	100
11.	$N_3P_2K_1$	250	150	50
12.	$N_3P_2K_2$	250	150	100

bed. While, the plant samples were collected at the end of the experiment. The observations related to vegetative and flowering parameters were recorded using standard procedures. The comparative LSD multiple range test (P= 0.05) was used to determine differences between treatments.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Growth parameters :

The data on growth parameters presented in Table 1 show that, 250 kg/ha nitrogen recorded highest plant height (97.21 cm) and plant spread (1090.77 cm^2). The similar trend was noted for fresh and dry weight of plant (216.24 and 69.27 g, respectively). However, they were found at par with an application of 200 kg/ha. The number of suckers per plant (4.16) also noted best results with application of 250 kg/ha. The poorest response was observed in 150 kg/ha for all growth parameters. Improvement in all above parameters was caused due to drawing of photosynthate to the flower as consequence of intensification of sink. Also it might be due to the improved vegetative growth of plant under the highest level of nitrogen, which resulted in more storage and subsequent utilization of carbohydrates and thus improved various flower characters. The results are in agreement with Sodha and Dhaduk (2002) and Rajput (2005) in golden rod and Yadav *et al*. (2003) in tuberose.

The data on growth parameters presented in Table 1 also show that, the application of phosphorus @ 150 kg/ha gave significant results with plant height (95.72 cm), plant spread (1069.04 cm^2) and fresh and dry weight of plant (213.78 and 65.68 g, respectively). The number of suckers per plant (3.18) was also noted best results with application of 150 kg/ha. However, dry weight of plant and number of suckers per plant

Table 1 : Effect of N, P and K on growth parameters of golden rod

Treatments	Plant height (cm)	Plant spread (cm^2)	Fresh weight of plant (g)	Dry weight of plant (g)	Number of suckers per plant
Levels of nitrogen					
N_1	91.55	1030.65	203.20	60.40	2.21
N_2	92.38	1033.40	211.13	66.50	3.04
N_3	97.21	1090.77	216.24	69.27	4.16
S.E. ±	1.32	12.86	2.30	1.98	0.14
C.D. (P=0.05)	3.87	37.34	8.81	5.81	0.43
Levels of phosphorus					
P_1	91.17	1033.51	206.60	65.11	3.09
P_2	95.72	1069.04	213.78	65.68	3.18
S.E. ±	1.07	10.50	2.45	1.61	0.11
C.D. (P=0.05)	3.16	30.81	NS	NS	NS
Levels of potassium					
K_1	92.06	1035.46	205.05	62.90	3.05
K_2	95.36	1067.09	215.33	67.88	3.23
S.E. ±	1.07	10.50	2.45	1.61	0.11
C.D. (P=0.05)	3.16	30.81	7.19	4.74	NS
Interactions					
N×P	NS	NS	NS	NS	NS
P×K	NS	NS	NS	NS	Sig.
N×K	NS	NS	NS	NS	NS
N×P×K	NS	NS	NS	NS	NS
C.V. %	4.88	4.24	4.95	10.50	16.18

NS=Non-significant

were found at par with an application of 100 kg/ha. The result may be due to vital role of phosphorus in plant growth as it is an essential constituent of cell components such as phosphoproteids and phospholipids, which are indispensable constituents of the various cell membranes and are also important for the maintenance of cell structure. These results are in agreement with the findings of Bankar and Mukhopadhyay (1990) who observed that phosphorus had marginal effect for improving in plant height and leaf numbers. It was also in confirming with those of Biswas and Parya (2008) in golden rod and Gaikwad *et al*. (2004) in China aster.

The data on growth parameters presented in Table 1 show that, the application of potassium @ 100 kg/ha gave significant results with plant height (95.36 cm), plant spread (1067.09 cm^2) and fresh and dry weight of plant (215.33 and 67.88 g, respectively). The number of suckers per plant (3.23) also noted best results with application of 100 kg/ha. It might be due to role of potassium as is not a constituent of any organic compound, however it is required as a cofactor for 80 or more enzymes. It controls movement of stomata and maintains electro-neutrality of plant cells (Marschner, 1995). These results are in conformity with those obtained by Biswas and Parya (2008) in golden rod, Singatkar *et al.* (1995) and Karetha (2006) in gaillardia, Baboo and Sharma (1997) and De and Dhiman (1998) in chrysanthemum.

Yield parameters :

From data on yield parameters presented in Table 2 was observed that, the maximum fresh weight of panicle (48.45 g), dry weight of panicle (18.00 g), numbers of panicles (1.92) per plant and numbers of panicles per hectare (3.40 lacks) were also obtained with highest level of nitrogen 250 kg/ha. This might be due to vigorous growth and development of panicles with increase nitrogen level, which ultimately resulted in maximum weight of panicles. The results are in line with Rao *et al.* (1992) in chrysanthemum and Singatkar *et al.* (1995) in gaillardia. Above results were also found in line with Rajput (2005) and Biswas and Parya (2008) in golden rod, Bankar and Mukhopadhyay (1990) in tuberose for yield of spike per hectare.

From data on yield parameters presented in Table 2 was observed that, application of phosphorus @ 150 kg/ha recorded significantly higher phosphorus availability as compared to 100 kg/ha, likes fresh weight (46.61 g) and dry weight (17.61 g) of panicle, number of panicle per plant (1.86) and number of panicle per hectare (3.27 lakhs) were also recorded under 150 kg/ha. The similar results were obtained by Lale *et al.* (2003) in golden rod, Singatkar *et al.* (1995) in

Table 2 : Effect of N, P and K on yield parameters of golden rod

Treatments	Fresh weight of panicle (g)	Dry weight of panicle (g)	Number of panicles per plant	Yield of panicles (lacs per hectare)
Levels of nitrogen				
N_1	40.57	15.52	1.51	2.82
N_2	45.51	16.33	1.86	3.02
N_3	48.45	18.00	1.92	3.40
S.E. ±	1.65	0.65	0.07	0.12
C.D. (P=0.05)	4.85	1.91	0.22	0.36
Levels of phosphorus				
P_1	42.41	15.64	1.67	2.90
P_2	46.61	17.61	1.86	3.27
S.E. ±	1.35	0.53	0.06	0.10
C.D. (P=0.05)	3.96	1.56	0.18	0.30
Levels of potassium				
K_1	41.83	15.82	1.76	2.98
K_2	47.20	17.43	1.77	3.18
S.E. ±	1.35	0.53	0.06	0.10
C.D. (P=0.05)	3.96	1.56	NS	NS
Interactions				
N×P	NS	NS	NS	NS
P×K	NS	NS	NS	NS
N×K	NS	NS	NS	NS
N×P×K	NS	NS	NS	NS
C.V. %	12.89	13.59	14.81	14.08

NS=Non-significant

Table 3 : Interaction effect of (P × K) on number of suckers per plant

Phosphorus levels (P)	Potassium levels (K)	
	K_1 50 kg/ha	K_2 100 kg/ha
P_1 100 kg/ha	3.18	3.00
P_2 150 kg/ha	2.91	3.46
S.E. ±	0.16	
C.D. (P=0.05)	0.49	

gaillardia and Kumar *et al.* (2002) in China aster. The increased availability of phosphorus in soil might have enhanced root growth in terms of root surface area, as well as volume, which might have favoured phosphorus absorption by roots and subsequent translocation to shoots. Higher dry weight and phosphorus content in vegetative, as well as flower parts with phosphorus fertilization, collectively increased uptake of phosphorus by plant.

The data on yield parameters presented on Table 2 show that, application of potassium @ 100 kg/ha was recorded significantly higher as compared to 50 kg/ha. The result indicated higher yield attributes likes fresh weight (47.20g) and dry weight (17.43 g) of panicle, number of panicle per plant (1.77) at par with 50 kg/ha and number of panicles per hectare (3.18 lakhs) were also recorded under 100 kg/ha. Application of potassium might have increased availability of potassium in root zone and stimulated root growth in terms of surface area and volume of roots, which might have favoured the absorption of potassium as reported by. Biswas and Parya (2008) in golden rod and Baboo and Singh (2003) in chrysanthemum.

The data in Table 3 indicate that highest number of suckers per plant (3.46) were recorded with an application of 150 kg P + 100 kg K/ha (P_2K_2). However, it was observed statistically at par with treatment combinations P_1K_1 and P_1K_2. The lowest number of suckers (2.91) was recorded with combination P_2K_1.

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