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Effect of FYM and GA_3 on growth and yield of Sweet flag (*Acorus calamus* L.) under Terai zone of West Bengal

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ABSTRACT

A field experiment was conducted during 2003 - 04 and 2004 - 05 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, to study the effect of different levels of Farm Yard Manure (FYM) (0, 12.5, 25, 37.5 and 50 t ha^{-1}) and GA_3 (0 and 100 ppm) on production in Sweet Flag. The experiment was laid out in Factorial Randomized Block Design with three replications. Farm Yard Manure significantly affected yield and vegetative characters. GA_3 also showed similar effect, except, that rhizome diameter and dry-recovery percentage were found non-significant. Interaction effect between FYM and GA_3 for growth and yield parameters was found non-significant. Plant height, number of leaves, rhizome length, rhizome diameter and yield increased with increase in dose of FYM from 0 to 50 t ha^{-1} but was reverse in the case of dry recovery. Similarly, these parameters increased with application of GA_3 but showed non-significant relationship, except in rhizome yield. Maximum fresh and dry rhizome yield (3013.23 kg ha^{-1}, 1389.15 kg ha^{-1} respectively) was recorded with 50 t ha^{-1} FYM supplemented with 100 ppm GA_3, followed by application of 50 t ha^{-1} FYM (2879.80 and 1342.65 kg ha^{-1}, respectively).

Key words : *Acorus calamus* L., dry recovery, FYM, GA_3, growth, Sweet flag, yield

INTRODUCTION

Sweet flag (*Acorus calamus* L.), commonly known as 'Batch', is an important minor spice cum medicinal and aromatic plant belonging to the family Araceae. It is a semi-aquatic perennial herb with long, creeping, much branched, aromatic rhizomes and fibrous root and occurs widely all over India, especially in hilly tracts (Selvi *et al.* 2003). It is mainly cultivated in the Netherlands, Persia, United Kingdom, India and Sri Lanka. In India, it is common in Kashmir and the Kumayun region of Himalayas. However, it is cultivated in Karnataka, Kashmir, Manipur and Nagaland. Root is used for treatment of Kwashiorkor disease in children. The rhizomes are used as carminative, stimulant and tonic (Jain, 2001). Rhizome extracts are used against feeling of over-fullness, flatulence and colic pain. It contains 1.5 to 3.5% essential oil. The essential oil extracted from the rhizome is utilized in perfumery. At lower dose, it also has a stimulating effect. It has been used in purifying water. Due to presence of acorin in its essential oil, it is commonly used as a remedy for asthma and chronic diarrhoea. "Bach" is a commercial product available in the market, also prepared from sweet flag. Fresh rhizomes are used in confectionery and also used as a substitute for ginger (Farooqui *et al*, 2000). In West Bengal, ground dried - rhizome and rhizome powder is used in bait for fishing. The smoke of Sweet flag, taken orally through a funnel, relieves cough. It can be a good source of earning from lands that are low-lying and where other crops cannot grow. Application of organic matter improves soil physical and chemical properties and also improves the productivity of the crop (Deka and Patgiri, 2002). Productivity in this crop is very low compared to other root crops. Use of plant growth regulators, in addition to other package of practices, is an important factor for increasing productivity and quality of the produce manifold (Krishnamurthy, 1975). Beneficial effect of GA_3 on yield has been well-established in many crops like potato (Tomar and Ramgiry, 1977), onion (Gawad *et al*, 1986; Singh *et al*, 2002) and garlic (Rahman *et al*, 2004). For along crop duration (about 10 months) and its rhizomatous nature, it requires heavy input of fertilizers. But, continuous use of inorganic chemical fertilizer negatively affects soil environment and pollutes underground water. It

is essential to reduce indiscriminate use of inorganic chemical fertilizer and to simultaneously increase the use of organic manures which improve soil, plant health and plant growth regulators. Therefore, the present investigation was carried out to assess efficacy of Gibberelic acid (GA_3) with FYM on growth, yield and quality of Sweet flag in Terai zone of West Bengal.

MATERIAL AND METHODS

The experiment was conducted during 2003 - 04 and 2004 - 05 at the Instructional Farm ($26^0$19'86" N latitude, $89^0$23'53" E longitude, altitude of 43 m amsl) of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal to study the effect of different levels of FYM (0, 12.5, 25, 37.5 and 50 t ha^{-1}) and GA_3 (0 and 100 ppm) on production in Sweet flag. The crop was grown under rain-fed condition. The total amount of rainfall received was 323.21 cm during 2003 - 04 and 301.09 cm during 2004-05, respectively. The experiment was laid out in Factorial Randomized Block Design with three replications. The soil was sandy-loam and coarse with poor water-holding capacity and the climate was humid tropical. All the doses of FYM were applied during final land preparation. GA_3 was applied one month after planting of Sweet flag as spray in GA_3 treated plots and only water was sprayed in control plots. Rhizome bits of 5 cm with growing tops were transplanted in the field in a plot of 1.50 m x 2.10 m size with a spacing of 30 cm x 30 cm. In both years the crop was transplanted during the third week of March and harvested during the 3rd week of January. The crop was given recommended package of practices excluding the fertilizer schedule. No inorganic fertilizers were added. Observations on various growth and yield characters were recorded twice, from ten randomly selected plants in each replication (excluding the border row) at 180 days after transplanting and at harvest, respectively. Dry-recovery percentage was taken as dry-weight over fresh-weight of rhizomes. Statistical analysis was done as per Gomez and Gomez (1984).

RESULTS AND DISCUSSION

It has been found that growth and yield parameters are somewhat higher in the second year of study might be due to the favourable climatic condition like higher average sunshine hour. The results on plant height, numbers of leaves, rhizome length and diameter have been presented in Table 1. Plant height, number of leaves, rhizome length and diameter increased significantly with the increasing doses of FYM (0 to 50 t ha^{-1}). Lower growth and yield parameters (44.92, 12.64, 17.81 and 12.62 cm, respectively) were recorded in plants received no FYM and highest values (59.23, 19.35, 22.87 and 14.21 cm, respectively) observed in plants with the highest doses of FYM (50 t ha^{-1}).

Excepting rhizome diameter, all three growth and yield characters were significantly affected by application of GA_3. Maximum plant height (51.85 cm), number of leaves per plant (16.07) and rhizome length (20.74 cm) were recorded in100 ppm GA_3 treatment. Application of GA_3 also increased number of leaves as in case of potato (Singh *et al*, 2003). The interaction effect between GA_3 and FYM was non-significant for all the parameters recorded except for rhizome length of Sweet flag in the second year.

The results on fresh and dry yield and dry recovery have been presented in Table 2. Dry recovery percentage was inversely proportional to incremental doses of FYM. The highest dry recovery percentage (48.88%) was recorded from plants received no FYM and it was lowest (46.41%) in the highest doses (50 t ha^{-1}) of FYM, which was statistically *at par* with the 37.5 t ha^{-1} FYM treatment (46.97%). GA_3 had no significant effect on dry recovery percentage. The interaction effect between FYM and GA_3 was also found statistically significant, however, maximum dry recovery was obtained from the untreated plants. Though non significant, the maximum plant height (60.44 cm), rhizome diameter (14.26 mm) and number of leaves (19.77) were recorded in the plants treated with 50 t ha^{-1} FYM along with 100 ppm GA_3. Same treatment combination also showed maximum rhizome length (23.05 cm) of Sweet flag. Fresh and dry yield of Sweet flag is significantly affected by FYM treatment. Fresh and dry yield increases with the increase in the doses of FYM from 0 to 50 t ha^{-1}. Maximum fresh and dry yield (2946 kg ha^{-1} and 1365.90 kg ha^{-1}, respectively) was recorded with 50 t ha^{-1} FYM followed by 37.5 t ha^{-1} FYM (2524.50 kg ha^{-1} and 1271.60 kg ha^{-1}, respectively) treatment. GA_3 also showed significant effect on fresh and dry yield of Sweet flag. The maximum fresh and dry yield (2568.75 kg ha^{-1} and 1212.84 kg ha^{-1}, respectively) was recorded with 100 ppm GA_3 treated plants.

Interaction effect of GA_3 and FYM on fresh and dry weight of Sweet flag was found statistically non-significant. However, maximum fresh and dry yield (3013.23 kg ha^{-1} and 1389.15 kg ha^{-1}, respectively) was obtained with the plants treated with 50 t ha^{-1} FYM along with 100 ppm GA_3. Higher rate of FYM increased the yield significantly and this might be due to higher availability of macro and micro plant nutrients throughout the growth period which

Table 1. Effect of Farm Yard Manure and GA_3 on plant height, leaf number, rhizome length and diameter in Sweet Flag

Treatment	Plant height (cm)			Number of leaves			Rhizome length (cm)			Rhizome diameter (mm)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
FYM (t ha^{-1})												
F_0 (0)	40.37	49.47	44.92	12.32	12.95	12.64	17.47	18.15	17.81	12.41	12.83	12.62
F_1 (12.5)	42.80	50.70	46.75	13.50	14.13	13.82	19.47	20.02	19.75	13.08	13.38	13.23
F_2 (25)	47.93	52.20	50.07	15.02	15.53	15.28	19.89	20.89	20.39	13.47	13.82	13.65
F_3 (37.5)	50.67	57.07	53.87	17.10	17.57	17.34	21.88	21.75	21.82	13.82	14.13	13.98
F_4 (50)	57.28	61.18	59.23	18.43	20.27	19.35	22.62	23.11	22.87	13.84	14.58	14.21
SEm±	0.95	1.05	0.71	0.42	0.53	0.34	0.48	0.35	0.31	0.31	0.24	0.25
CD (*P= 0.05*)	2.85	4.14	2.13	1.27	1.59	1.02	1.44	1.05	0.93	0.94	0.72	0.74
GA_3 (ppm)												
G_0 (0)	46.88	53.39	50.14	14.89	15.64	15.27	20.07	20.55	20.31	13.27	13.64	13.46
G_1 (100)	48.83	54.86	51.85	15.60	16.53	16.07	20.46	21.02	20.74	13.39	13.80	13.60
SEm±	0.60	0.67	0.45	0.27	0.33	0.21	0.31	0.13	0.13	0.19	0.15	0.19
CD (*P= 0.05*)	1.79	2.01	1.34	0.81	1.00	0.62	N.S.	0.39	0.38	N.S.	N. S.	N. S.
FYM x GA_3												
F_0 G_0	39.67	49.07	44.37	11.97	12.37	12.17	17.18	17.49	17.34	12.38	12.67	12.53
F_0 G_1	41.07	49.87	45.47	12.67	13.53	13.10	17.75	18.51	18.13	12.45	12.99	12.72
F_1 G_0	42.00	49.77	45.89	12.93	13.67	13.30	19.31	19.86	19.59	13.01	13.34	13.18
F_1 G_1	43.60	51.63	47.62	13.77	14.60	14.18	19.63	20.18	19.91	13.16	13.42	13.29
F_2 G_0	47.27	51.27	49.27	14.43	15.07	14.75	19.67	20.74	20.21	13.29	13.71	13.50
F_2 G_1	48.60	53.13	50.87	15.60	16.0	15.80	20.10	21.03	20.57	13.65	13.93	13.79
F_3 G_0	49.0	56.67	52.84	17.2	17.17	17.18	21.64	21.52	21.58	13.80	14.01	13.91
F_3 G_1	52.33	57.47	54.90	17.00	17.97	17.48	22.11	21.98	22.05	13.85	14.25	14.05
F_4 G_0	56.00	60.17	58.09	17.90	19.97	18.93	22.56	22.81	22.69	13.85	14.47	14.16
F_4 G_1	58.67	62.20	60.44	18.97	20.57	19.77	22.68	23.42	23.05	13.82	14.69	14.26
S Em±	1.34	1.49	1.00	0.59	0.74	0.48	0.68	0.49	0.34	0.43	0.34	0.29
CD (*P= 0.05*)	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S	N S

N S =Non-significant

Table 2. Effect of Farm Yard Manure and GA_3 on yield and recovery in Sweet flag

Treatment	Yield (kg ha^{-1})			Dry recovery (%)			Dry yield (kg ha^{-1})		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
FYM (t ha^{-1})									
F_0 (0)	1917.14	2285.59	2101.37	48.58	49.18	48.88	931.20	1120.59	1025.90
F_1 (12.5)	2113.76	2441.80	2277.78	47.88	48.67	48.28	101.93	1188.43	645.18
F_2 (25)	2272.49	2685.18	2478.84	47.30	47.92	47.61	1074.34	1285.99	1180.17
F_3 (37.5)	2487.88	2944.44	2716.16	46.40	47.53	46.97	1148.35	1394.85	1271.60
F_4 (50)	2705.00	3187.83	2946.42	45.87	46.95	46.41	1239.90	1491.89	1365.90
SEm±	54.88	49.73	86.38	0.40	0.36	0.27	27.13	25.27	24.52
CD (*P= 0.05*)	163.07	147.74	256.64	1.19	1.07	0.82	80.61	75.09	72.86
GA_3 (ppm)									
G_0 (0)	2242.91	2637.03	2439.97	47.43	48.23	47.83	1060.66	1268.64	1164.65
G_1 (100)	2356.60	2780.90	2568.75	46.98	47.87	47.43	1101.62	1324.05	1212.84
SEm±	34.71	31.45	63.91	0.25	0.23	0.17	12.35	15.98	17.50
CD (*P= 0.05*)	103.14	93.44	191.73	NS	N. S.	N.S.	37.05	47.49	51.63
FYM x GA_3									
F_0 G_0	1862.34	2232.81	2047.58	49.20	49.53	49.37	916.04	1105.14	1010.59
F_0 G_1	1973.55	2338.38	2155.97	47.97	48.83	48.40	946.35	1136.04	1041.20
F_1 G_0	2079.37	2354.50	2216.94	48.07	48.73	48.40	999.35	1147.19	1073.27
F_1 G_1	2148.15	2529.10	2338.63	47.70	48.60	48.15	1024.50	1229.66	1127.08
F_2 G_0	2206.35	2597.83	2402.09	47.30	48.07	47.69	1043.09	1247.33	1145.21
F_2 G_1	2338.62	2772.49	2555.56	47.30	47.77	47.54	1105.60	1324.64	1215.12
F_3 G_0	2417.99	2888.89	2653.44	46.47	47.73	47.10	1124.67	1378.41	1251.54
F_3 G_1	2557.77	3000.00	2778.89	46.33	47.33	46.83	1172.04	1411.29	1291.67
F_4 G_0	2648.50	3111.10	2879.80	46.13	47.10	46.62	1220.16	1465.14	1342.65
F_4 G_1	2761.91	3264.55	3013.23	45.60	46.80	46.20	1259.65	1518.64	1389.15
SEm±	77.62	70.32	84.08	0.57	0.51	0.38	38.37	35.74	27.67
CD (*P= 0.05*)	N S	N S	N S	N S	N S	N S	N S	N S	N S

NS =Non-significant

increased the available nutrient status of the soil resulting better growth and yield of the crop. Application of GA_3 enhanced growth parameters like plant height, number of leaves which ultimately enhanced canopy photosynthesis and consequently increased the length and diameter of rhizome which ultimately increased yield as observed by Gawad *et al* (1986) and Singh *et al* (2002) in onion and Rahman *et al* (2004) in garlic.

From the above discussion, it may be concluded that increase in application of FYM from 0 to 50 t ha^{-1} along with GA_3 has increased rhizome yield of Sweet flag and an application of 50 t ha^{-1} FYM along with 100 ppm GA_3 exhibited maximum yield (3013.23 kg ha^{-1} and 1389.15 kg ha^{-1} fresh and dry, respectively) and hence, both FYM and GA_3 are beneficial for increasing the rhizome yield of Sweet flag for the zone of study.

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