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Effect of organic substances on growth and yield of greater yam (*Dioscorea alata* L.)

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Abstract
The experiment entitled "Effect of organic substances on growth and yield of greater yam (*Dioscorea alata* L.)" was conducted at Horticultural Research Farm of Pt. Kishori Lal Shukla College of Horticulture and Research Station, Pendri, Rajnandgaon, Indira Gandhi Krishi Vishwavidyalaya Raipur, Chhattisgarh. The Growth and yield parameter like vine girth on base (cm), vine length 23 & 180 dap (m), number of vines per plant, petiole length (cm), tuber yield per plant (kg) and tuber yield (t h^{-1}) were significantly superior in the treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae (VAM) @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The maximum vine girth on base (0.80 cm) was recorded under treatment T_{11}. The maximum vine length at 20 DAP (1.30 m) and 180 DAP (9.00 m) were recorded under treatment T_{11}. The highest number of vines per plant (3.50) was recorded under treatment T_{11}. The maximum petiole length (9.93cm) was recorded under treatment T_{11}. The maximum tuber yield per plant (2.03 kg) was recorded under treatment T_{11}. The maximum tuber yield (25.10 t ha^{-1}) was recorded under treatment T_{11}.

Keywords: Vine girth, VAM, *Azospirillum*, paddy straw compost, petiole length, tuber yield, goat manure, *Dioscorea alata*

1. Introduction
Greater yam (*Dioscorea alata* L.) belongs to the family Dioscoreaceae and it has chromosome number (2n=2x=20 & 2n=4x=40). It belongs to genus Dioscorea which contains about 600 species (Coursey, 1967) [3]. Greater yam (*Dioscorea alata* L.) popularly known as Ratalu and Khamalu and Chupri aloo in Hindi, is an important commercial vegetable crop grown throughout India. It contains anthocyanin pigment in its bright lavender colour in tuber which can be extracted as food colourant (Jose *et al*., 2015) [5].

It is a perennial crop usually grown as an annual. It is a valuable starchy staple food crop in tropical, sub-tropical and frost-free temperate climate of the world and historically played an important role in the quest for food and the struggle for human survival in several countries (Asadu and Akammigbo, 1996) [1]. The edible part of yam is the underground starchy stem called 'tuber'. The tuber shape is generally cylindrical but can be extremely variable. Tuber flesh is white & red and 'watery' in texture. Greater yam originated from South East Asia. Yams are cultivated as a food source by more than 100 million people especially in many developing countries (Lebot, 2009) [7]. It is usually associated with traditional agriculture systems, known to maintain a wide genetic reservoir represented by several varieties bearing several vernacular names (Siqueira *et al*., 2014) [12].

Greater yam is a most ethnic tuber crop having more demand in market during November month on *Devuthani* festival in Chhattisgarh. The area of Greater yam in Chhattisgarh is 216.60 ha with the production and productivity of 5833.07 tonnes and 23.94 t ha^{-1} in respectively. Freshly harvested tubers of Greater yam are consumed as boiled, baked, fried and as a vegetable like potato (Shankar and Singh, 2018) [11]. Yam also provides cash income for a wide range of smallholders, including many women as producers, processors and traders (Assiedu, 2003) [2]. *D. alata* is superior to most edible yam species in terms of high yield potential especially under low to average soil fertility, ease of propagation (production of bulbils and reliability of sprouting), early vigor for weed suppression and storability of tubers (Wu *et al*., 2005) [14].

In India, greater yam is cultivated in the states of Andhra Pradesh, Kerala, West Bengal, Bihar, Odisha, North Eastern states, Uttar Pradesh, Tamil Nadu, Gujarat and Maharashtra (Chadha, 2002).

2. Materials and Methods

The present investigation entitled "Effect of organic substances on growth, yield and quality of greater yam (*Dioscorea alata* L.)" was conducted during *Kharif* season of 2019-20 at Horticultural Research cum Institutional Farm, Pt. K.L.S. College of Horticulture and Research Station, Pendri, Rajnandgaon, Indira Gandhi Krishi Vishwavidyalaya Raipur, Chhattisgarh.

Climatologically, Rajnandgaon witnesses normal tropical wet and dry climate. An average annual rainfall of 1200 mm is generally appeared and mostly concentrated during the period from June to September. The major portion of the rainfall is received by South-Western monsoon. The May and December is the hottest and coolest month of the year respectively. In general, weekly maximum temperature goes upto 45 °C during the summer season and minimum temperature falls upto 5 °C during the winter season.

Soil acts as the crucial and essential medium for plant growth. Soil fertility and productivity are the major factors for the growth and development of the plant. To examine the original fertility grade of the field, soil samples from 15 cm depth were collected randomly from altered parts of the field through the core sampler, which were processed and further subjected to suitable chemical and physical analysis. The data on physico-chemical properties of experimental field, which revealed that texture of soil of experimental field was sandy clay soil. The soil was neutral in reaction, medium in organic carbon, low in nitrogen and medium in phosphorus and potash content.

The experiment was laid out in Randomized Block Design (RBD) with three replications, thirteen treatment were allocated in each replication. Healthy tuber of greater yam cv. (Chhattisgarh Ratalu – 1) collected from SGCARS, Jagdalpur were used for planting. Greater yam tuber of 250- 300 g size were cut and dipped in to mixture of cow dung slurry with *Trichoderma viride* in order to prevent soil born fungi. Treated tubers were kept under the shade for 3 hrs before planting.

Greater yam with long and semi- hard vine, a stake is a stick firmly embedded in the earth. It is best to use hard wood, which done at 75 cm. of plant height. Basically it is a vine crop, hence, the vines have to be staked for better yield. The staking is done with the help of bamboo poles of 3-4 m length and 10-15 cm thick so that the leaves are exposed to sun light and this encourages more photosynthesis. Yield from the staked plants are generally higher than those of non staked plants.

3. Results and Discussion

The data recorded on growth and yield aspects were statistically analyzed using standard statistical methods to test their significance and are tabulated illustrated for clarity. The results on the present investigation along with appropriate discussion, are presented below and Table 1.

The data revealed that the vine girth on base was found significant for all organic substances. The maximum vine girth on base (0.80 cm) was recorded under treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The application of organic substance had a significant impact on vine growth of greater yam. The reason behind the result might be due to significant positive effect of combination of particular organic manure and compost on the vine girth on base of the plant and the contribution added by the combination of organic manure and compost to the level of fertility in the soils. When the manure and compost starts decomposition most of the macro as well as micro nutrient is enhanced in the soil which improves physical and chemical properties of the soil and ultimate increase the vegetative parameter of the plants. The similar findings have also been reported by Meena *et al*., (2018) [9].

The data revealed that the vine length was found significant for all organic substances. The maximum vine length at 20 DAP (1.30 m) and 180 DAP (9.00 m) were recorded under treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The maximum vine length recorded in treatment might be due to significant positive effect of combination of particular organic manure and compost on the vine length of the plant and the contribution added by the combination of organic manure and compost to the level of fertility in the soils. When the manure and compost starts decomposition most of the macro as well as micro nutrient is enhanced in the soil which improves physical and chemical properties of the soil and ultimate increase the vegetative parameter of the plants. Results collaborate with the finding of Sosina *et al*. (2018) [13].

The data revealed that the number of vines per plant was found significant for all organic substances. The maximum number of vines per plant (3.50) was recorded under treatment T_{11}(Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The reason behind the result might be due to better nutritional environment near the rhizoshphere and high fertility level of the soil which ultimately increased the more number of vines per plant.

The application of various combination of organic substance had a significant impact on petiole length of greater yam. The maximum petiole length (9.93cm) was recorded under treatment T_{11}(Goat manure @ 1.66 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). This reason behind the result might be due to because the application of compost mixture and biofertilizer supplied the essential nutrients to plants during the growth and development stages.

The application of various combination of organic substance had a significant impact on tuber yield of greater yam. The maximum tuber yield per plant (2.03 kg) was recorded under treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The higher nutrient in soil is linked to tuber yield $plant^{-1}$(kg) which was applied by various combinations of compost and manures. The result are accordance with the finding of Lucien *et al.* (2009) [8].

The application of various combination of organic substance had a significant impact on tuber yield of greater yam. The maximum tuber yield (25.10 t ha^{-1}) was recorded under treatment T_{11}(Goat manure @ 1.66 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + vesicular Arbuscular Mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}). The reason behind the result must be due to the Integration of organic manure having high C:N ratio with manure having low C:N ratio increase the mineralization and organic matter build up with efficient microbial activity. Which ultimately enhanced the growth and yield of yam. An increase in the measure of organic fertilizer resulted in an increase in yield. The higher nutrient in soil is

linked to tuber yield (t ha^{-1}) which was applied by various combinations of compost and manures. Finding is accordance with the results of Kaswala *et al*., (2013) [6] Enwezor WO *et al*., (1988) [4] and Saravaiya *et al*., (2011) [10].

Table 1: Effect of organic substances on Growth and yield parameter of Greater Yam

Tr. no.	Treatment details	Vine girth on base (cm)	Vine length(m) at 20& 180 DAP		Number of vines per plant
			20 DAP	180 DAP	
T_1	Farmyard manure @ 10 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.41	0.75	7.15	2.00
T_2	Farmyard manure @ 10 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.43	0.78	7.32	2.31
T_3	Farmyard manure @ 10 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.48	0.91	7.56	2.50
T_4	Vermicompost @ 2.1 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.45	0.88	7.45	2.40
T_5	Vermicompost @ 2.1 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.58	1.05	7.98	2.95
T_6	Vermicompost @ 2.1 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.60	1.10	8.07	3.10
T_7	Poultry manure @ 1.65 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.51	0.95	7.70	2.61
T_8	Poultry manure @ 1.65 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.64	1.14	8.40	3.21
T_9	Poultry manure @ 1.65 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.71	1.17	8.65	3.35
T_{10}	Goat manure @ 1.66 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.55	1.00	7.85	2.75
T_{11}	Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.80	1.30	9.00	3.50
T_{12}	Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	0.75	1.23	8.80	3.42
T_{13}	Farmyard manure @ 10 t ha^{-1} + NPK (RDF) @ 80:60:80 kg ha^{-1}(Control)	0.40	0.70	6.67	1.87
S.Em (±)		0.04	0.05	0.46	0.17
CD (5%) =		0.13	0.17	1.35	0.50
CV (%) =		13.35	10.04	10.18	10.75

Conti…..

Tr. no.	Treatment details	Petiole length (cm)	Tuber yield per plant (kg)	Tuber yield (t ha^{-1})
T_1	Farmyard manure @ 10 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	7.81	1.55	19.10
T_2	Farmyard manure @ 10 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.20	1.63	20.08
T_3	Farmyard manure @ 10 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.40	1.71	21.07
T_4	Vermicompost @ 2.1 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.35	1.67	20.58
T_5	Vermicompost @ 2.1 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.65	1.84	22.72
T_6	Vermicompost @ 2.1 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.69	1.82	22.51
T_7	Poultry manure @ 1.65 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.50	1.72	21.19
T_8	Poultry manure @ 1.65 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.74	1.90	23.46
T_9	Poultry manure @ 1.65 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.80	1.91	23.58
T_{10}	Goat manure @ 1.66 t ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.59	1.78	21.98
T_{11}	Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	9.93	2.03	25.10
T_{12}	Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}	8.95	1.97	24.32
T_{13}	Farmyard manure @ 10 t ha^{-1} + NPK (RDF) @ 80:60:80 kg ha^{-1}(Control)	7.00	1.50	18.52
S.Em (±)		0.41	0.10	1.33
CD (5%) =		1.21	0.32	3.89
CV (%) =		8.46	10.56	10.56

4. Conclusion

The Growth and yield parameter like vine girth on base (cm), vine length 23 & 180 dap (m), number of vines per plant, petiole length (cm), tuber yield per plant (kg) and tuber yield (t h^{-1}) were significantly superior in the treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae (VAM) @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}).

On the basis of above findings, treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae (VAM) @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}) stand first in position and T_{12} (Goat manure @ 1.66 t

ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + phosphorus solublizing bacteria (PSB) @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}) stand in second order of preference. However, treatment T_9 comes in next in order. There for it may be concluded that treatment T_{11} (Goat manure @ 1.66 t ha^{-1} + *Azospirillum*@ 5 kg ha^{-1} + vesicular arbuscular mycorrhizae (VAM) @ 5 kg ha^{-1} + paddy straw compost @ 5 t ha^{-1}) may be prefer for higher growth and yield in greater yam.

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