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Effect of Organic Input Application on Soil Microbial and Biochemical Properties on Gladiolus (*Gladiolus grandiflorus* L.) under Jorhat Condition

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A B S T R A C T

Soil enzymes, microbial biomass carbon (MBC), soil microbial population and soil biochemical properties were assessed to understand the influence of different organic inputs on gladiolus under open condition during 2015-16 to 2016-17. The experiment was laid out with 8 treatments in Randomized Block Design and replicated 3 times. The treatments were T_1 [RDF(20:20:20g m^{-2} NPK + 4kg m^{-2} FYM)], T_2 [Rock phosphate + Microbial consortium], T_3[T_2 + Vermicompost (2.5 t ha^{-1})], T_4 [T_2 + Vermicompost (5 t ha^{-1})], T_5 [T_2 + Compost (2.5 t ha^{-1})], T_6 [T_2 + Compost (5 t ha^{-1})], T_7 [Enriched compost (2.5 t ha^{-1})] and T_8 [Enriched compost (5t ha^{-1})]. The soil enzymes fluorescein di-acetate (FDA), phosphomonoesterase (PMEase), dehydrogenase (DH), arylesterase (ARE) and arylsulphatase (ARS) involved in energy flow and nutrient cycling showed significant higher activities under different organic inputs. T_8 (Enriched compost 5t ha^{-1}) demonstrated clear increase in FDA (8.35 µg fluorescein g^{-1} soil h^{-1}), PMEase (63.76 µg *p*-nitrophenol g^{-1} soil h^{-1}), DH (125.42 µg TPF g^{-1} soil 24 h^{-1}), ARS (20.79 µg *p*-nitrophenol g^{-1} soil h^{-1}), ARE (147.97µg *p*-nitrophenol g^{-1} soil h^{-1}), MBC (522.90 µg g^{-1} soil) and microbial population in gladiolus. Maximum organic carbon (1.12%) accumulation was observed in treatment T_8.

Introduction

Gladiolus (*Gladiolus grandiflorus* L.) belongs to the family Iridaceae and native to Europe, Mediterrenean region and South Africa. It is also known as queen of bulbous ornamental plants and sword lily. It has fascinating spikes that contains attractive, elegant, dazzling and delicate florets that open in sequence over longer duration and hence having good keeping quality for cut spikes. It is mainly used for garden, interior decoration and for making bouquets. It is available in various range of colour from blackish to white, pink, violet, lilace or mauve, greenish, smoky and combinations of these colours are also available (Singh *et al.*, 2014).

Gladiolus has a high nutrient requirement and hence proper fertilization is essential for its cultivation. The continuous and unbalanced use of conventional fertilizers leads to decreased nutrient uptake efficiency of plants resulting in decreased crop yield. It also causes serious threat to soil health. Steady decline in soil organic matter levels due to continuous cropping with injudicious applications of chemical fertilizers has led to negative nutrient balances in Indian agriculture, impaired soil health and weaken factor productivity (Rao, 2007). Recent studies have focused on traditional fertilization practices to enhance soil organic input by amendments of crop residues, green manure, and farmyard manure.

To boost up the yield potential use of organic manure and bio-agents plays an important role in enhancing its flowering and corm yield. As reported in numerous studies, *Azosprillum* and *Azotobacter* are well known symbiotic N-fixing bacteria which help the plants indirectly through better nitrogen fixation or improving the nutrient availability in the soil. Biofertilizers also control and suppress soil borne diseases and some of inoculants produce antibiotics (Aldrich and Baker, 1970). Organic farming is a production system which avoids or largely excludes the use of synthetically produced fertilizers, pesticides, growth regulators and livestock feed additives. Organic farming methods combine scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes

Materials and Methods

The present experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat-13 during 2015-16 and 2016-17. The experiment was laid out with 8 treatments in Randomized Block Design and replicated 3 times. The treatments were T_1 [RDF(20:20:20g m^{-2} NPK + 4kg m^{-2} FYM)], T_2 [Rock phosphate + Microbial consortium], T_3[T_2 + Vermicompost (2.5 t ha^{-1})], T_4 [T_2 + Vermicompost (5 t ha^{-1})], T_5 [T_2 + Compost (2.5 t ha^{-1})], T_6 [T_2 + Compost (5 t ha^{-1})], T_7 [Enriched compost (2.5 t ha^{-1})] and T_8 [Enriched compost (5t ha^{-1})] to study the effect of organic input application on soil microbial and biochemical properties on gladiolus

Results and Discussion

The present research work was carried out to study the effect of organic inputs on soil microbial and biochemical properties on gladiolus. The results obtained from the present investigation as well as relevant discussion have been summarized below:

Effect of organics on soil biological properties

Soil microbial biomass carbon, MBC (µg g^{-1} soil 24 $hour^{-1}$)

Data presented in Table 1, shows significant variation in MBC. The highest MBC (522.90 µg g^{-1} soil 24 $hour^{-1}$) was recorded in the application of T_8 (Enriched compost 5t ha^{-1}). This may be due to the application of organic source of nutrients which improves the microbial and enzymatic activities in soil (Rajkonwar, 2012).

Dehydrogenase (DH) activity (µg TPF g^{-1} soil 24 $hour^{-1}$)

The data in Table 1, shows that the activity of DH enzyme in soil increased significantly due to application of organic sources. The DH activity was higher in T_8 (125.42µg TPF g^{-1} soil 24 $hour^{-1}$). The effect of higher microbial activity and MBC resulted in higher DH activity. The DH plays an important role in the initial stages of the oxidation of soil organic matter and is one of the reliable criteria that signify microbial activity in a given situation. The enzyme is considered to exist as an integral part of intact cell but does not accumulate extracellularly in soil.

The application of organic minerals which contains crop residues, animal faeces and their compost etc. to soil usually increases the soil biomass and DH activities (Subhani *et al.*, 2001).

Phosphomonoesterase (PMEase) activity (µg p-nitrophenol g^{-1} soil $hour^{-1}$)

From the Table 1, it is observed that highest PMEase activity of 63.76µg p-nitrophenol g^{-1} soil $hour^{-1}$ under the soil treated with treatment T_8 (Enriched compost 5t ha^{-1}). Rock phosphate carrying enriched compost could have augmented the available phosphate in the treatment. It may be due to the release of more organically bound phosphate as a result of synthesis of enzyme which is stimulated by the presence of organic substrate (Biswas and Narayanaswamy, 2006).

Fluorescein Di-acetate Hydrolysis (FDA) activity (µg fluorescein g^{-1} soil $hour^{-1}$)

Data in Table 1, shows significant variation in FDA activity (8.35µg fluorescein g^{-1} soil $hour^{-1}$) in the soil treated with T_8 (enriched compost 5t ha^{-1}). FDA activity determines the live cells present in the soil

Arylsulphatase (ARS) and Arylesterase (ARE) activity (µg p-nitrophenol g^{-1} soil $hour^{-1}$)

Similarly significant variation is observed in ARS activity (20.79µg p-nitrophenol g^{-1} soil $hour^{-1}$) and ARE activity (147.97µg p-nitrophenol g^{-1} soil $hour^{-1}$). Arylsulphatase play a major role in the turnover and cycling of sulphur in soils by catalysing the hydrolysis of ester sulphates, and thus releasing organically bound sulphates into the soil solution Arylesterase activity is important for evaluating the response of soil microbial communities to organic contamination and remediation measures as it catalyses the hydrolysis of toxic metabolites and organophosphates and degradation of plastics. Addition of organic sources acts as a good source of carbon and energy to heterotrophs or microbes which keep them alive for a longer period of time. This is in conformity with Albiach *et al.*, (2000) and Chang *et al.*, (2007).

Microbial population (log cfu g^{-1} soil)

It is clearly observed from the Table 1, that the highest microbial population of bacteria (7.11 log cfu g^{-1} soil) and fungal 4.16 log cfu g^{-1} soil was recorded in T_8 (Enriched compost 5t ha^{-1}). Sources of potential beneficial microbes in the enriched compost may possibly provide microbial diversity and activity of microorganisms accompanied by better DH and PMEase activity. Similar findings were also reported by Nath *et al.*, 2012.

Manure application is known to stimulate and improve stable soil structure, fungal and bacterial population and biological activity (Chaoui *et al.*, 2003).

Effect of organics on soil physico-chemical properties

Soil pH ad organic carbon

Data from Table 2 clearly indicates that there was a significant increase in soil pH (5.55) and organic carbon (1.12%) when Enriched compost 5t ha^{-1} (T_8) was applied to soil. Soil pH is a manifestation of H^+ and OH^- activity by dissociation of water molecules. Higher pH in the organic treatments might be due to the deactivation of Al^{3+} and concomitant release of basic cations due to addition of organic matter (Gogoi, 2010).

Table.1 Data of Microbial biomass carbon, dehudrogenase activity, phosphomonoesterase activity, fluorescein di-acetate activity, arylesterase activity, arylsulphate activity, bacteria and fungi

Treatment	Microbial Biomass Carbon, (µg g^{-1}soil 24 $hour^{-1}$)	Dehydrogenase activity (µg TPF g^{-1}soil 24 $hour^{-1}$)	Phosphomonoesterase activity (µg p-nitrophenol g^{-1} soil $hour^{-1}$)	Fluorescein di-acetate activity (µg fluorescein g^{-1} soil $hour^{-1}$)	Arylsulphatase activity (µg p-nitrophenol g^{-1} soil $hour^{-1}$)	Arylesterase activity (µg p-nitrophenol g^{-1} soil $hour^{-1}$)	Bacteria (log cfu g^{-1} soil)	Fungi (log cfu g^{-1} soil)
T_1 : RDF (20:20:20 g m^{-2} NPK + 4 kg m^{-2} FYM)	262.00	92.40	40.66	4.70	13.29	126.50	5.32	3.28
T_2 : Rock phosphate + Consortium	237.55	90.92	37.18	5.15	14.60	127.64	5.25	3.23
T_3 : T_2 + Vermicompost (2.5t ha^{-1})	449.94	106.63	44.78	6.13	18.34	134.09	6.05	3.44
T_4 : T_2 + Vermicompost (5t ha^{-1})	500.90	112.76	51.36	6.29	18.47	142.78	6.22	3.47
T_5 : T_2 + Compost (2.5t ha^{-1})	311.95	95.79	40.84	5.32	15.72	127.05	5.39	3.34
T_6 : T_2 + Compost (5t ha^{-1})	364.72	99.27	42.91	5.62	16.42	131.67	5.45	3.38
T_7 : Enriched Compost (2.5t ha^{-1})	500.10	115.38	51.97	7.28	18.31	140.60	6.23	3.72
T_8 : Enriched Compost (5t ha^{-1})	522.90	125.42	63.76	8.35	20.79	147.97	7.11	4.16
S.Ed (±)	3.86	2.83	1.01	0.33	0.48	1.81	0.37	0.10
CD (5%)	8.27	6.07	2.17	0.71	1.02	3.88	0.79	0.22

Table.2 Data of effect of organics on soil pH, organic carbon, Available N, P and K

Treatment	pH	Organic Carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1 : RDF(20:20:20 g m^{-2} NPK + 4 kg m^{-2} FYM)	4.58	0.68	257.57	31.61	129.75
T_2 : Rock phosphate + Consortium	5.21	0.73	263.47	30.10	123.18
T_3 : T_2 + Vermicompost (2.5t ha^{-1})	5.22	0.87	268.67	37.92	135.48
T_4 : T_2 + Vermicompost (5t ha^{-1})	5.26	0.90	273.50	48.35	136.69
T_5 : T_2 + Compost (2.5t ha^{-1})	5.11	0.76	264.76	34.62	127.62
T_6 : T_2 + Compost (5t ha^{-1})	5.19	0.78	269.67	36.08	128.67
T_7 : Enriched Compost (2.5t ha^{-1})	5.25	0.88	272.30	45.04	135.23
T_8 : Enriched Compost (5t ha^{-1})	5.55	1.12	282.62	54.94	143.22
S.Ed (±)	0.10	0.04	1.92	0.62	2.57
CD (5%)	0.22	0.09	4.11	1.32	5.51

Also, higher pH might be due to the increase in microbial activities in the root zone which decomposes organic manures and also fix unavailable form of mineral nutrient into available forms in soil thereby substantiates crop requirement and improve organic carbon level and stabilize soil pH. Similar result was also reported by Tekasangla *et al.,* (2015) in cauliflower. Organic carbon of soil acts as a sink and source of nutrients for microbial population, which regulates the availability of different nutrients through microbial transformation it is probably due to application of organic inputs and their releasing behaviour of different acids. However, before experimentation organic carbon and soil pH of 0.63% and 5.06 were found respectively.

Available nitrogen, phosphorus and potassium

Data presented in table 2, shows that there is significant variation in available nitrogen, phosphorus and potassium.

Available form of nitrogen is always in a state of dynamic change and hence its content in soil is highly variable. The highest available nitrogen of 282.62 kg ha^{-1} were recorded under treatment T_8 (Enriched compost 5t ha^{-1}). Such a buildup of available N could be attributed to the availability of *Rhizobium* with *Azotobacter* to fix atmospheric N in the rhizosphere throughout the cropping period. Similar results have been reported by Workneh *et al.,* (1993). Organically managed soil exhibited great of biological activity of inoculated microorganisms as well as their potential nitrogen fixation (Melero *et al.,* 2006).

The highest available soil phosphorus status (54.94kg ha-1) was recorded in T8 (Enriched compost 5t ha-1). The increased available phosphorus might be attributed to the improvement of soil condition due to the application of compost and phosphate solubilising and mineralizing ability of the microorganisms from the soluble from of phosphorus sources (Tao *et al.,* 2008). Microbial culture plays a vital role in the release of phosphorus sources due to production of phosphate solubilising enzymes. The minimum phosphorus content of soil (30.10kg ha^{-1}) was recorded in consortium with rock phosphate inoculated treatment (T_2) which might be due to the lower rate of fixation of phosphorus during initial stage. These results were similar to the findings by Bahadur *et al.,* 2006; Biswas (2008) and Umlong (2010).

In case of residual potassium, treatment T_8 receiving Enriched compost 5t ha^{-1} showed higher potassium content of 143.22 kg ha^{-1}. This might be due to release of potassium from these organic amendments and also due to solubilisation of mineral based potassium or native potassium. The positive influence of organic manure on the available potassium was earlier reported by Srikanth *et al.,* (2000).

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