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Response of gingelly to conjoint application of inorganic fertilizers, organic manure, bioinoculants and biostimulant on growth and yield in Typic ustifluvent

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Abstract

A field experiment was conducted on gingelly during summer season of 2022 in sandy loam soil at farmer's holding at Vallampadugai village, Cuddalore district, Tamil Nadu, India to study the effect of combined application of inorganic fertilizers, organic manure, biofertilizer and seaweed extract on growth, yield attributes and yield of gingelly. The experiment was laid out in randomized block design and replicated three times. The growth, yield attributes and yield were recorded at 30 DAS, 60 DAS and at harvest stage. The results of the experiment revealed that the application of 75% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1} + seaweed extract @15% registered the maximum growth attributes *viz.,* plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, leaf area index and chlorophyll content. The highest value of yield attributes *viz.,* number of capsules $plant^{-1}$ (89.36), number of seeds $capsule^{-1}$ (75.79), 1000 seed weight (3.36 g) and seed yield (1064.2 kg ha^{-1}), stover yield (1874.3 kg ha^{-1}), biological yield (2938.5 kg ha^{-1}) and harvest index (36.22 %).

Oilseed crops plays second key role in the Indian agricultural economy next to food grains in terms of production and area. The Indian climate is suitable for the cultivation of oilseed crops. Consequently, a wide variety of oilseeds are grown here. Among the oilseed crops, gingelly (*Sesamum indicum* L.) is well known and is one of the oldest crops in the world[27]. *Sesamum indicum* is grown both in the tropics and in temperate regions around

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the world,[3] and cultivated for its high-quality oil[4]. Gingelly seeds are rich source of edible oil, biomedicine and food nutrition. Sesame is usually rich in oil about 50 % and protein about 18 - 20 %. Nearly 78 % of the gingelly seed produced in India is uses for oil extraction, 2.5 % for planting purposes and the rest is uses in confections and in religious Hindu ceremonies. Nearly 73 % of oil is uses for edible purposes, 8.3 % for hydrogenation and 4.2 % for industrial purposes in the manufacture of paints, pharmaceuticals, manufacture of soaps and insecticides.

According to studies, consuming nutrients in unbalanced quantities and at sub-optimal rates over time severely depleted the soil's nutrient reserves in India, leading to a variety of nutrient deficiencies and a drop in crop output. Use of synthetic fertilizers alone to boost crop yields in the initial year has a negative impact on sustainability in the long term. Sustainability of crop production is not a viable proposition either through use of organic manures or chemical fertilizers alone[21]. The usage of chemical fertilizer is expected to increase agricultural yields by more than 50%. Sustainable agriculture would inevitably use organic manures to meet crop nutrient requirements because they not only increase yield but also preserve the soil's physical, chemical and biological properties. It is commonly acknowledged that applying organic manure alone might serve as a comprehensive strategy for attaining agriculture because it is nature-based, environmentally beneficial and ensures resource conservation for the future. Essential elements that are bound up in organic manures are slowly mineralized and made accessible to the crops, which aids in stimulating growth and yield while also enhancing soil fertility. The use of chemical fertilizers cannot be ruled out completely, there is a need for integrated application of alternate source of nutrient for sustaining soil productivity[23]. Considering these limitations, bio inoculants are the best alternative strategy and numerous researchers have noted the advantages of incorporating bio fertilizers on crop development, yield and soil fertility maintenance[17]. Biofertilizers are low cost and eco-friendly input have tremendous potential for supplying nutrients. The supplementary and complementary use of organic manures and chemical fertilizers augment the efficiency of both the substances to maintain a high level of soil productivity[6]. Unlike chemical fertilizers, use of seaweed as fertilizer is expected to be an alternative solution to environmental problems because it is safe for soil microbes and plants. Additionally, it has been found that the growth-promoting hormone present in seaweed extract could increase growth and yield of gingelly[29]. It contains hormones such as auxin, cytokinin, and gibberellin[28]. Gingelly has demonstrated that the integrated supply and use of plant nutrients from chemical fertilizers and organic manures results in higher growth and yield of gingelly. Hence, the present investigation was carried out to find out the response of gingelly to inorganic fertilizers, organic manure, bio fertilizers and bio stimulant on growth and yield.

A field experiment was conducted at farmer's field Vallampadugai village, Chidambaram taluk, Cuddalore district during 2022 to find the effect of response of gingelly to inorganic fertilizers, organic manure, bio fertilizers and bio stimulant on growth and yield, as the test crop under irrigated condition with

ten treatments replicated thrice in a randomized block design. The experimental soil was sandy loam soil. The treatments were T_1 - 100% recommended dose of fertilizers 35:23:23 N, P_2O_5 K_2O kg ha^{-1}, T_2 – poultry manure @ 10 t ha^{-1} , T_3 - 50% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1}, T_4 - 75% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1}, T_5 - poultry manure @ 10 t ha^{-1} + biofertilizer consortium, T_6 - 50% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1}+ biofertilizer consortium, T_7 - 75% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1} + biofertilizer consortium, T_8– poultry manure @ 10 t ha^{-1} +seaweed extract @15%, T_9 - 50% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1}+ seaweed extract @15%, T_{10} - 75% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15%. As per the treatments specification, fertilizers were applied in the form of urea, Diammonium phosphate (DAP), Murate of potash (MOP) for the source of nitrogen, phosphorus and potassium, respectively. The biofertilizer inoculants like nitrogen fixing bacteria (*Azospirillum)* and *Phosphobacteria (Bacillus megaterium) and bio control agent (Pesudomonas fluorescens)* were applied. The seaweed extract was given as a foliar spray at 30 and 60 DAS. Growth, yield attributes and yield were analysed at 30,60 DAS and harvest stages of gingelly.

Growth Parameters (Table-1)

Plant height :

From the data, it is found that the plant height of gingelly was significantly influenced by the integrated application of inorganic fertilizers, organic manure, biofertilizers and seaweed extract in different combinations. Among the different treatments experimented, the application of 75% RDF+ poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) registered the maximum plant height of 64.46, 102.14 and 139.35 at 30 DAS, 60 DAS and at harvest stage, respectively. This was followed by the treatment T_7 which received 75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium recorded plant height of 59.03 cm at 30 DAS, 93.82 cm at 60 DAS and 129.79 cm at harvest stage. The treatment T_7 (75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium) was followed by T_4 with application of 75% RDF + poultry manure @ 10 t ha^{-1}. This was found to be on par with T_1 which received 100% RDF alone registering the value plant height of 53.60, 83.82 and 116.20 cm at 30 DAS, 60 DAS and at harvest stage, respectively. This was followed by T_9, T_6, T_3, T_8 and T_5. The lowest plant height of 26.24, 44.73 and 75.12 cm at 30, 60 DAS and at harvest were recorded in T_2 (poultry manure @ 10 t ha^{-1}). It is possible that the supply of macro elements through the recommended dose of fertilizers which promoted the gingelly plant to grow higher. The increased plant height might also be due to the application of poultry manure which contains high N content and was made available to plants through mineralization to stimulate the plant growth and also increased uptake of primary nutrients and rapid photosynthate movements inside the plant system[26]. Further, increased biomass accumulation and crop growth were noticed under integrated application of seaweed extracts and alone with chemical

Table-1. Effect of INM on growth parameters of gingelly

Treatment Details	Plant height (cm)			No. of branches plant^{-1}			No. of leaves plant^{-1}			Leaf area index			Chlorophyll content	
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS
T_1 - (100 % RDF) 35:23:23 N, P_2O_5, K_2O kg ha^{-1}	53.60	83.82	116.20	7.10	9.13	10.96	19.18	54.47	38.50	2.76	5.04	3.45	41.60	45.89
T_2 - Poultry manure @ 10 t ha^{-1}	23.24	44.73	75.12	4.52	6.07	7.35	13.91	34.70	24.59	1.71	3.40	2.36	29.91	33.01
T_3 - 50% RDF + Poultry manure @ 10 t ha^{-1}	39.14	64.33	96.20	5.76	7.57	9.04	16.41	43.80	31.81	2.20	4.19	2.87	35.38	39.21
T_4 -75% RDF + Poultry manure @ 10 t ha^{-1}	54.83	86.47	119.45	7.25	9.27	11.22	19.70	55.68	39.74	2.85	5.18	3.56	42.96	47.30
T_5 - Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	30.56	52.96	81.59	4.99	6.52	7.97	14.72	37.71	27.62	1.89	3.65	2.54	31.67	35.17
T_6 - 50% RDF + Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	43.27	71.38	102.74	6.12	8.08	9.61	17.40	46.78	33.82	2.40	4.45	3.06	37.33	41.36
T_7 - 75% RDF + Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	59.03	93.82	129.79	7.67	9.80	11.90	20.53	59.79	42.75	3.02	5.50	3.73	45.42	49.91
T_8 - Poultry manure @ 10 t ha^{-1} + Seaweed Extract @15%	34.12	59.10	88.06	5.40	7.09	8.52	15.54	40.59	29.83	2.04	3.92	2.70	33.58	37.25
T_9 - 50% RDF + Poultry manure @ 10 t ha^{-1} + Seaweed Extract @ 15%	47.39	77.61	108.97	6.59	8.56	10.22	18.26	50.34	36.18	2.57	4.75	3.24	39.39	43.57
T_{10} - 75% RDF + Poultry manure @ 10 t ha^{-1} + Seaweed Extract @ 15%	64.46	102.14	139.35	8.23	10.42	12.64	21.56	63.68	45.56	3.20	5.78	3.92	47.56	52.14
SEd	1.25	1.98	2.73	0.12	0.15	0.19	0.35	1.09	0.77	0.06	0.09	0.06	0.81	0.89
CD (p=0.05)	2.56	4.06	5.56	0.29	0.38	0.45	0.77	2.24	1.61	0.13	0.21	0.15	1.68	1.85

Table-2. Effect of INM on yield attributes and yield of gingelly

Treatment Details	No. of capsule plant^{-1}	No. of seeds plant^{-1}	1000 seed weight	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield	Harvest Index (%)
T_1 - (100 % RDF) 35:23:23 N, P_2O_5, K_2O kg ha^{-1}	79.27	66.25	3.12	900.1	1649.3	2549.4	35.31
T_2 - Poultry manure @ 10 t ha^{-1}	43.47	44.56	2.61	548.4	1124.4	1672.8	32.78
T_3 - 50% RDF + Poultry manure @ 10 t ha^{-1}	67.50	56.01	3.00	742.3	1400.6	2142.9	34.64
T_4 -75% RDF + Poultry manure @ 10 t ha^{-1}	80.79	67.79	3.19	938.4	1703.8	2642.2	35.52
T_5 - Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	59.15	50.01	2.88	626.8	1237.5	1864.3	33.60
T_6 - 50% RDF + Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	71.22	59.22	3.03	800.7	1478.2	2278.9	35.12
T_7 - 75% RDF + Poultry manure @ 10 t ha^{-1} + Biofertilizer consortium	84.68	71.47	3.24	999.5	1785.1	2784.6	35.88
T_8 - Poultry manure @ 10 t ha^{-1} + Seaweed Extract @15%	62.78	52.95	2.94	686.2	1316.4	2002.6	34.43
T_9 - 50% RDF + Poultry manure @ 10 t ha^{-1} + Seaweed Extract @ 15%	75.25	63.00	3.09	848.6	1559.5	2408.1	35.23
T_{10} - 75% RDF + Poultry manure @ 10 t ha^{-1} + Seaweed Extract @ 15%	89.36	75.79	3.36	1064.2	1874.3	2938.5	36.22
SEd	1.59	1.34	0.05	22.64	36.82	53.98	-
CD (p=0.05)	3.24	2.73	NS	45.63	73.81	108.24	-

fertilizers due to utilization of benefits of both[5,10]. As a result, the presence of growth-promoting hormone auxin, seaweed extracts have beneficial effects on cell division and plant growth[8].

Number of branches plant^{-1}:

The appraisal of data revealed that the application of inorganic fertilizers, organic manures, biofertilizers and seaweed extract significantly influenced differed in the number of branches plant^{-1} at 30, 60 DAS and at harvest stage of gingelly. Among various combinations experimented, the maximum number of branches plant^{-1} of 8.23, 10.42 and 12.64 at 30, 60 DAS and at harvest stage respectively were recorded under the treatment T_{10} (75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15%). This treatment was followed by T_7 (7.67, 9.80 and 11.90 at 30, 60 DAS and at harvest respectively). T_3 was statistically on par with T_1. The treatment T_9, T_6, T_3, T_8 and T_5 were next in order. The lowest number of branches plant^{-1} was recorded in the treatment T_2 (4.52, 6.07 and 7.35 at 30, 60 DAS and at harvest, respectively). The poultry manure contains more macro and micronutrients and the recommended dose of NPK fertilizers provide nutrients to the plant and significant effect on number of branches per plant. This outcome is in accordance with the study's findings of Alabi[1], and Gokul *et al.,*[7]. The foliar spray of seaweed extract may possibly responsible for the increased number of branches at 30 and 60 DAS that could have encouraged a greater number of auxiliary buds and number of productive branches. Similar outcomes of improved branching with foliar nutrient and NPK fertilisers applications were reported by Muthumanickam and Anburani[15]. Nitrogen supplied through inorganic fertilizer, poultry manure and biofertilizers (*Azospirillum, Phosphobacteria* and *pseudomonas fluorescens*) had a significant effect on number of branches per plant as it activates vegetative growth. These findings demonstrated that the appropriate levels of nitrogen and phosphorus had an influence on the number of branches per plant at the time of final harvest. Similar result was reported by Tumbare and Bhoite[24]. Moreover, Seaweed extract applied to the plant as a foliar spray in solution form is easier to obtain and produces more number of branches.

Number of leaves plant^{-1} :

The number of leaves plant^{-1} was significantly influenced by different integrated nutrient management practices. The data with respect to 30, 60 DAS and at harvest, the maximum number of leaves plant^{-1} was observed with application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) with number of leaves plant^{-1} of 21.56, 63.68 and 45.56, respectively. The treatment next in order was 75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium, (T_7). This was followed by the treatments T_9, T_6, T_3, T_8 and T_5. However, the treatments T_4 and T_1 were not significantly different from each other at 30, 60 DAS and at harvest stage. The minimum number of leaves plant^{-1} of 13.91, 34.70 and 24.59 were recorded in the treatment with application of poultry manure @ 10 t ha^{-1} (T_2) at different stages of plant growth *viz*., 30, 60 DAS and at

harvest stage. The results clearly indicate that integrated use of chemical fertilizer, organic manure, biofertilizers and bio stimulant was better than application of chemical and organic or biofertilizer or chemical sources of nutrient alone. This may be due to supply of nutrients from diversified sources and prolonged availability of nutrients to the growing plants. The beneficial role of free-living nitrogen fixing microorganisms for enhancing plant growth through their ability in nitrogen fixation as well as the effect of their metabolites secretion on the crop may also be attributed for the same. Using organic manure to supplement chemical fertilizer with respect to N might have resulted in good supply of potassium also. The better nutrient uptake and photosynthesis, as well as great physiological and biochemical activities brought on by the application of biofertilizers and seaweed extract, might be the causes of the increase in leaf number. These results are in agreement with Verma *et al.,*[25].

Chlorophyll content :

The perusal of data revealed that inorganic fertilizers, organic manure, biofertilizers and seaweed extract had significant effect on chlorophyll content of gingelly leaves determined at 30 and 60 DAS At 30 and 60 DAS, the maximum SPAD values of chlorophyll content (47.56 and 52.14) were observed in the treatment with application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% and this was followed by 75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium, (T_7). The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5. However, the treatment T_4 was on par with T_1 registering the value 41.60 and 45.89 at 30 and 60 DAS. The minimum SPAD values of chlorophyll content (29.91 and 33.01 at 30 and 60 DAS) was observed in the treatment applied with poultry manure @ 10 t ha^{-1} (T_2). Additionally, the integrated use of chemical fertilisers and seaweed extracts increased photosynthetic activity, which positively influenced the translocation of photosynthates from leaves to seed and increased the leaf's chlorophyll content and light interception[19]. The poultry manure used in this treatment might have supplied the gingelly plant with the necessary nitrogen to increase the chlorophyll content. The production of amino acids and the preparation of the starch in leaves are both dependent on the nitrogen, which is a component of the chlorophyll molecule. These results are in conformity with the findings of Khandaker *et al*.[11]. This might be attributed to the nitrogen present in inorganic fertilizers, poultry manure, biofertilizers (*Azospirillum, phosphobacteria and pseudomonas fluorescens)* which involved in the formation of chlorophyll and thereby leads to effective photosynthetic rate of gingelly plant.

Leaf area index :

The application of inorganic fertilizers, organic manure, bio fertilizers and bio stimulant caused a significant increase in leaf area index of gingelly. The data with respect to 30, 60 DAS and at harvest stage, the maximum leaf area index was observed with application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) with leaf area index of 3.20, 5.78 and 3.92 respectively. The treatment next in order was application of 75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium, (T_7). This was

followed by the treatments T_4, T_1, T_9, T_6, T_3, T_8 and T_5. However, the treatments T_4 and T_1 were comparable to each other at 30, 60 DAS and at harvest. The minimum leaf area index of 1.71, 3.40 and 2.36 was recorded in the treatment with application of poultry manure @ 10 t ha^{-1} (T_2) at different stages of plant growth *viz*., 30, 60 DAS and at harvest stage. This might be as a result of the presence of dry matter in organic manure, namely poultry manure, which has higher levels of nutrients and light absorption, increasing leaf area, photosynthetic activity, and plant development. These results are in agreement with findings of Islam *et al.*[9]. The increase in leaf area caused by the nitrogen supply from N fertilizer, poultry manure, *Azospirillum*, and seaweed extract might be due to the higher nutrient supply, which induced cell division and expansion, which increased the size of each individual leaves as reported by Pathak *et al.,*[16]. The use of inorganic fertilisers, organic manure, biofertilizers, and bio stimulants was held responsible for the increase in plant spread. These activities resulted in higher levels of nutrients in plants, including nitrogen, phosphorus, and potassium, as well as higher levels of plant metabolites, which helped to strengthen the tissues of the plants. The increase in leaf area could be attributed to improved photosynthesis, nutritional uptake, and physiological and biochemical activities brought by the use of *Azosprillum and Phosphobacteria*. These results are in conformity with the findings of Malik *et al.*[14].

Yield attributes (Table-2) :

Number of capsule $plant^{-1}$:

Application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) recorded the maximum number of capsule $plant^{-1}$ (89.36). This was followed by T_7 (75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium) which recorded number of capsule $plant^{-1}$ (84.68). The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5. T_4 and T_1 was not significant with each other. The minimum number of capsule $plant^{-1}$ (43.47) was recorded in T_2. This superior effect on number of capsules $plant^{-1}$ might be due to better integration effect of inorganic sources, poultry manure, biofertilizers along with seaweed extract which enhanced better root proliferation, more uptake of nutrients and water, higher plant growth, more photosynthesis and enhanced food accumulation and thereby improved the fruit diameter[2]. Similar results of increases in number of capsules $plant^{-1}$ due to the application of NPK fertilizers at different doses along with seaweed extract were also reported by Satapathy *et al.*[19].

Number of seeds $capsule^{-1}$:

The results showed that the maximum number of seeds $capsule^{-1}$ was registered in the treatment T_{10} (75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15%). The treatment next in line was T_7 recording number of seeds $capsule^{-1}$ of 71.47. The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5. The treatment T_2 recorded the minimum number of seeds $capsule^{-1}$ (44.56). The increased number of seed $capsule^{-1}$ was attributed to balanced C:N ratio, more decomposition, more mineralization, more availability of native and applied macro and

micro nutrients, more solubilization effect and availability of nutrients by the addition of organic manures as well as chemical fertilizers and more physiological activity leading to the build-up of sufficient food reserves for the developing sinks and better portioning towards the developing fruit[12].

1000 seed weight :

The maximum 1000 seed weight was recorded in treatment T_{10} (75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15%). This treatment was not significant with all other combined treatments. The minimum 1000 seed weight (2.61) was registered in T_2 (poultry manure@ 10 t ha^{-1}). This might be due to production of healthy seed by combined application of inorganic fertilizers, poultry manure, biofertilizers (*Azospirillum* and *Phosphobacteria*) and foliar application of seaweed extract which improved the quality of seed and it leads to maximum thousand seed weight. These results are in conformation with Sultana *et al.*[22].

Seed yield :

The seed yield of gingelly was affected by combined application of inorganic fertilizers, organic manure, biofertilizers and seaweed extract. The results revealed that application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) recorded the highest seed yield of 1064.2 kg ha^{-1} followed by the application of 75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium (T_7) which registered the yield of 999.5 kg ha^{-1}. The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5 registering the seed yield of 938.4, 900.1, 848.6, 800.7, 742.3 686.2 and 626.8 kg ha^{-1}. T_4 and T_1 was not significantly different from each other. The minimum of 548.4 kg ha^{-1} of seed yield was recorded with the application of poultry manure@ 10 t ha^{-1} (T_2). Optimal availability of nitrogen and phosphorus due to non-symbiotic fixation of nitrogen by *Azotobacter* and solubilisation of unavailable phosphate to available form by *PSB*, respectively, as well as direct assimilation of major, secondary and micro nutrients along with cytokinin and auxins after foliar application of seaweed extract, enhanced yield of gingelly plants. However, reverse was true in case of other treatments, therefore, attained the inferior values of yield. These results are in close conformity with the findings of Singh *et al.*,[20]. Application of seaweed extracts in combination with the chemical fertilizers (RDF) increased seed yield of gingelly was observed by Pramanick *et al.*,[18].

Stover yield :

The results connected to stover yield was significantly influenced by the inclusion of inorganic fertilizers, organic manure, bio fertilizers and bio stimulant. Among the various distribution of inorganic fertilizers, organic manure, bio fertilizers and seaweed extract tried, the application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) registered the stover yield of 1874.3 kg ha^{-1} and this was followed by treatment T_7 (75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium) registering the yield of 1478.2 kg ha^{-1}. The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5. However,

the treatments T_4 and T_1 were not significant from each other. The minimum stover yield of 1124.4 kg ha^{-1} was observed in T_2.

Biological yield :

The biological yield (Seed yield + Stover yield) of gingelly crop was significantly influenced by combined application of inorganic fertilizers, organic manure, bio fertilizers and seaweed extract. The maximum biological yield (2938.5 kg ha^{-1}) was registered with application of 75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15% (T_{10}) and it was followed by treatment T_7 (75% RDF + poultry manure @ 10 t ha^{-1} + biofertilizer consortium) which recorded the biological yield of 2784.6 kg ha^{-1}. The treatments next in order were T_4, T_1, T_9, T_6, T_3, T_8, and T_5 registering the seed yield of 2642.2, 2549.4, 2408.1, 2278.9, 2142.9, 2002.6 and 2142 kg ha^{-1}. T_4 and T_1 was not significantly different from each other. Application of poultry manure@ 10 t ha^{-1} (T_2) registered the minimum biological yield of 1672.8 kg ha^{-1}. The application of inorganic fertilizers, organic nutrient and biofertilizers (*Azospirillum, Phosphobacteria and Pesudomonas fluorescens*) to the soil at early stage and vegetative growth stage is favoured the vigorous growth and establishment of crop, with sustained nutrient availability leads to better uptake of NPK by the crop might have contributed to the increased seed and stover yield which had a favourable effect in getting increased in biological yield. Similar findings were reported by Lazacanaro and Domenguez[13].

Harvest index :

The maximum harvest index (36.22%) was found in treatment T_{10} (75% RDF + poultry manure @ 10 t ha^{-1} + seaweed extract @ 15%). There was no significant difference with application of different inorganic fertilizers, organic manure, biofertilizers and seaweed extract. The lowest harvest index (32.78 %) was observed in T_2 (poultry manure@ 10 t ha^{-1}). Harvest index was calculated depending upon the seed yield and biological yield.

On the basis of the above results, it may be concluded that combined application of inorganic fertilizers, organic manure, biofertilizers and seaweed extract resulted in higher growth and yield of gingelly. The results revealed that application of 75% recommended dose of fertilizers + poultry manure @ 10 t ha^{-1} through soil application along with seaweed extract @ 15% (T_{10}) at 30 and 60DAS as a foliar spray improved the growth and yield of gingelly compared to other treatments.

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