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Effect of organic manure and inorganic fertilizer on growth, yield and quality of garlic (*Allium sativum* L.)

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Abstract
The experiment entitled "Effect of Organic Manure and Inorganic Fertilizer on Growth, Yield and Quality of Garlic (*Allium sativum* L.)" was conducted during Rabi season of the year 2021-2022 on Instructional farm of Department of Horticulture, AKS University, Satna (M.P.). The experiment was laid out in Randomized Block Design comprising of 12 treatments *viz.*, T_1-Control, T_2-100% RDF (NPK), T_3-100% Vermicompost, T_4-100% FYM, T_5-100% Poultry manure, T_6-75% RDF + Poultry manure (10 q/ha), T_7-50% RDF + Poultry manure (20 q/ha), T_8-75% RDF + FYM (60 q/ha), T_9-50% RDF + FYM (120 q/ha), T_{10}-75% RDF + Vermicompost (40 q/ha), T_{11}-50% RDF + Vermicompost (80 q/ha), T_{12}-50% Poultry manure (13q/ha) + FYM (80 q/ha) + Vermicompost (53 q/ha), each replicated three times. Treatments were randomly arranged in each replication, divided into twelve plots. The results reveal that the application of 50% Poultry manure + 50% FYM + 50% Vermicompost (T_{12}) gave maximum plant height, highest number of leaves per plant, leaf area per plant, leaf length, leaf width, diameter of bulb, weight of the bulb, number of cloves per bulb, weight of the clove, yield per plot and bulb yield, Specific gravity of bulb, Dry matter content of leaf, Dry matter content of bulb and T.S.S. (^{O}Brix) of garlic.

Keywords: garlic, FYM, vermicompost, poultry manure, bulb yield, T.S.S.

Introduction
Garlic, (*Allium sativum*), a perennial plant of the Amaryllis family (Amaryllidaceae), is grown for its fragrant bulbs. The plant is native to Central Asia but grows wild in Italy and southern France and is an excellent ingredient in many national dishes. Garlic has long been known as cultivated plant in India Kumar *et al.* (2019) [2]. Garlic is the second most widely used cultivated *Allium* after onion. It has long been recognized all over the world as valuable spices for food and a popular remedy for various oilments and physiological disorders. Garlic has been used in medicine. It has been used in curing infection of lungs and respiratory passage Yadav, P.K. (2003) [8]. It is also used in internally for curing chronic, externally as a febefacient in skin diseases. According to Unani and Ayurvedic system as prescribed in India, garlic is carminative is gastric stimulant and thus helps in digestion and absorption of food Khar *et al.* (2004) [1]. Allicin present in aqueous extract of garlic reduces cholesterol concentration in the human blood.

Organic form of nutrient constitutes a potential renewable source of nutrient supply to crops under all situations. Organic sources are relatively bulky materials and are added mainly to improve the physical condition of soil, to replenish and keep up its humus status to maintain the optimum condition for the activities of soil micro-organism. Excreta of earthworms are called Vermicompost, which has several plant growth promoters, enzymes rich in plant nutrients, beneficial bacteria and mycorrhiza. Vermicompost is a rich mixture of major and minor plant nutrients, increase total microbial population of nitrogen fixing bacteria, actinomycetes and symbiotic association of mycorrhiza on plant root system Nezahat Turfan (2021) [3]. In recent years, Vermicompost is widely used in horticultural crop production and has all the characteristics to use it as most valuable organic manure. The use of FYM has been affected by shortfall in its supply, increasing demand for plant nutrients and increased use of manufactured fertilisers. FYM contains a high proportion of organic matter that nourishes soil organisms and is essential for maintaining an active soil life and is rich in nutrients.

Materials and Methods
The experiment entitled "Effect of Organic Manure and Inorganic Fertilizer on Growth, Yield and Quality of Garlic (*Allium sativum* L.)" was conducted during Rabi season of the year

2021-2022 on Instructional farm of Department of Horticulture, AKS University, Satna (M.P.). The experiment was laid out in Randomized Block Design comprising of 12 treatments *viz*., T_1-Control, T_2-100% RDF (NPK), T_3-100% Vermicompost, T_4-100% FYM, T_5-100% Poultry manure, T_6-75% RDF + Poultry manure (10 q/ha), T_7-50% RDF + Poultry manure (20 q/ha), T_8-75% RDF + FYM (60 q/ha), T_9-50% RDF + FYM (120 q/ha), T_{10}-75% RDF + Vermicompost (40 q/ha), T_{11}-50% RDF + Vermicompost (80 q/ha), T_{12}-50% Poultry manure (13q/ha) + FYM (80 q/ha) + Vermicompost (53 q/ha), each replicated three times. Treatments were randomly arranged in each replication, divided into twelve plots. Cloves of garlic were sown on 03rd November-2021, germination started and completed on 04th December the recording of observations was done 30 days after sowing and subsequent readings were recorded after every 30 days interval. The crop was harvested on 29th March-2022. For nitrogen Urea was used, for phosphorus, Di ammonium Phosphate and for potash Murate of Potash used. FYM, Poultry manure and Vermicompost obtained from department of horticulture, A.K.S. University, Satna (M.P.). Cloves of garlic for the experiment were obtained from Horticultural Research Farm of A.K.S. University, Satna (M.P.). The cloves were of uniform size of good quality and especially these cloves were dormant of six months and disease free. Cloves treated with 0.1% Bavistine solution before planting. For proper growth and development cloves of 150 Kg/ha is followed. Cloves are directly sown in a well prepared field or beds having sufficient soil moisture. Cloves are sown to a depth of 0.5 cm and after sowing the cloves were half covered with soil by the use of khurpi. Plant protection measures were followed to control the pest and diseases. Soil treatment with copper fungicide (Phytolan) at the rate of 3 ml/10 litres of water was drenched to protect the plants from fungal infection. Roger was used @ 10 ml/10 litres of water.

Results and Discussion

Data mentioned in table 1 clearly revealed that the optimum levels of nutrients were found to significantly improve plant height at all the growth stages. The maximum plant height at 30, 60 and 90 days after sowing (DAS) was recorded due to T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost (53 q/ha) (20.41, 40.15 and 68.74 cm respectively) and minimum plant height was recorded from the treatment T_1 with Control (13.22, 34.00 and 50.68 cm, respectively). The highest number of leaves per plant at 30, 60 and 90 days after sowing (DAS) was recorded from T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost (4.70, 09.87 and 19.93 respectively) and lowest number of leaves per plant was recorded from the treatment T_1 with Control (3.02, 6.30 and 12.47 respectively). The diameter of main shoot at 30, 60 and 90 days after sowing (DAS) was recorded from T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost (0.50 cm, 0.96 cm and 1.42 cm respectively) and lowest diameter of main shoot was recorded in case of T_1 with Control (0.33 cm, 0.74 cm and 1.16 cm respectively). Maximum leaf area per plant (138.11 cm^2) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (136.30 cm^2) 100% RDF (NPK). Minimum leaf area per plant (122.86 cm^2) was recorded in the treatment T_1 with Control. Maximum leaf length (17.41 cm) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (16.95 cm) 100% RDF (NPK). Minimum leaf length (10.18 cm) was recorded in the treatment T_1 with Control. Maximum leaf width (2.17 cm) for duration of flowering was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (2.14 cm) 100% RDF (NPK). Minimum leaf width (1.63 cm) was recorded in the treatment T_1 with Control. Maximum weight of the bulb (40.61 g per plant) for duration of harvesting was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (39.54 g per plant) 100% RDF (NPK). Minimum weight of the bulb (11.37 g per plant) for duration of harvesting was recorded in the treatment T_1 with Control. Maximum number of cloves per bulb (20.72) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (19.44 cloves per bulb) 100% RDF (NPK). Minimum number of cloves per bulb (10.36) was recorded in the treatment T_1 with Control. Maximum weight of the clove (1.86 g) for duration of harvesting was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (1.85 g) 100% RDF (NPK). Minimum weight of the clove (1.03 g) for duration of harvesting was recorded in the treatment T_1 with Control. Maximum yield per plot (2.192 kg) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (2.135 kg) 100% RDF (NPK). Minimum yield per plot (0.614 kg) was recorded in the treatment T_1 with Control. Maximum bulb yield (10.96 tones/hectare) was recorded in the treatment T_{12} with 50% Poultry manure (13q/ha) + FYM (80q/ha) + Vermicompost followed by T_2 as (10.67 tones/hectare) 100% RDF (NPK). These results are substantiated with Rakesh and Vinod (2005) [6], Patil *et al.* (2007) [5], Ranjan *et al.* (2010) [7] and Paczka *et al.* (2020) [4] in garlic. Minimum bulb yield (3.07 tones/hectare) was recorded in the treatment T_1 with Control. Maximum Bulb weight at harvest (38.15 g) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (36.09 g) 100% RDF (NPK). Minimum root length (10.68 g) was recorded in the treatment T_1 with Control. Maximum Specific gravity of bulb (0.97) was recorded in the treatment T_{12} with 50% Poultry manure (13q/ha) + FYM (80q/ha) + Vermicompost followed by T_2 as (0.95) 100% RDF (NPK). Minimum Specific gravity of bulb (0.83) was recorded in the T_1 with Control. Maximum Dry matter content of leaf (56.0%) was recorded in the treatment T_{12} with 50% Poultry manure (13q/ha) + FYM (80q/ha) + Vermicompost followed by T_2 as (49.5%) 100% RDF (NPK). Minimum Dry matter content of leaf (13.8%).was recorded in the T_1 with Control. Maximum Dry matter content of bulb (45.97%) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as (45.05%) 100% RDF (NPK). Minimum Dry matter content of bulb (36.02%) was recorded in the T_1 with Control. Maximum T.S.S. (49.13 ^{O}Brix) was recorded in the treatment T_{12} with 50% Poultry manure (13 q/ha) + FYM (80 q/ha) + Vermicompost followed by T_2 as T.S.S. (47.24 ^{O}Brix) 100% RDF (NPK). Minimum T.S.S. (32.47 ^{O}Brix) was recorded in the T_1 with Control.

Based on the results of the study in garlic, it is concluded that with application of 50% Poultry manure + 50% FYM + 50% Vermicompost (T_{12}) gave maximum plant height, highest number of leaves per plant, leaf area per plant, leaf length,

leaf width, diameter of bulb, weight of the bulb, number of cloves per bulb, weight of the clove, yield per plot and bulb yield, Specific gravity of bulb, Dry matter content of leaf, Dry matter content of bulb and T.S.S. (^{O}Brix) of garlic.

Table 1: Effect of Organic Manure and Inorganic Fertilizer on Growth, Yield and Quality of Garlic (*Allium sativum* L.)

Treatments	Plant height (cm)	Number of leaves per plant	Diameter of main shoot (cm)	Leaf area per plant (cm^2)	Weight of the bulb (g) per plant	Number of cloves per bulb	Weight of the clove (g)	Yield per plot (kg)	Bulb yield (tones/hectare)	Bulb weight at harvest (g)	Specific gravity of bulb	T.S.S. (^{O}Brix)
T_1	50.68	12.47	1.16	122.46	11.37	10.36	1.03	0.614	3.07	10.67	0.83	32.47
T_2	67.30	19.38	1.40	136.30	39.54	19.44	1.85	2.135	10.67	36.09	0.95	47.24
T_3	63.11	18.22	1.36	135.42	39.08	19.17	1.83	2.110	10.55	35.08	0.94	46.01
T_4	63.09	18.07	1.34	134.11	38.74	18.89	1.82	2.091	10.45	34.37	0.94	45.97
T_5	59.60	17.03	1.30	133.56	32.42	18.58	1.80	1.750	8.75	33.44	0.93	42.64
T_6	58.17	15.24	1.23	131.17	22.17	16.03	1.53	1.197	5.98	24.53	0.91	39.10
T_7	52.92	14.32	1.18	127.27	15.72	14.54	1.28	0.849	4.24	18.61	0.87	35.04
T_8	58.80	16.35	1.26	132.45	26.83	17.07	1.66	1.449	7.24	28.34	0.91	40.54
T_9	53.45	14.51	1.20	128.59	18.60	15.04	1.32	1.004	5.02	19.85	0.90	35.73
T_{10}	59.48	16.91	1.27	132.83	30.25	17.42	1.71	1.634	8.17	29.79	0.92	41.05
T_{11}	54.71	14.58	1.22	129.18	20.63	15.26	1.48	1.114	5.57	22.58	0.91	37.82
T_{12}	68.74	19.93	1.42	138.11	40.61	20.72	1.86	2.192	10.96	38.15	0.97	49.13
S.Ed(±)	1.24	0.30	0.03	2.73	0.42	0.33	0.04	0.03	0.15	0.12	0.15	0.11
CD at 5%	2.51	0.63	0.07	5.50	0.86	0.68	0.08	0.05	0.31	0.27	0.31	0.24

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