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Effect of organic manures and inorganic fertilizers on growth, yield and its attributing traits in garlic (*Allium sativum* L.)

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Abstract
An investigation was conducted at Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology during Rabi season of 2016-17 to study the effects of organic manures and inorganic fertilizers on growth, yield and its attributing traits in garlic.Ten treatments were compared in a Randomized Block Design with three replications. Among the different treatments, the treatment T_1 (application of 100 % RDF- Recommended Dose of Fertilizer) recorded the maximum plant height (70.6cm), plant diameter (0.84 cm) and length of longest leaf at 60 DAP (41.07 cm) and 90 DAP (69.47 cm) as compared to other treatments.Weight of bulb (39.68g), length (5.24 cm) and diameter of bulb (5.03 cm), number of cloves per bulb (27.63), length of clove (3.82cm),weight of single clove (1.52g) of competitive plants, bulb yield per plot(4.66kg) and bulb yield per ha (155.48q) was maximum in the treatment T_7 (50% RDF + 7.5t/ha FYM +2 t/ha Vermicompost).

Keywords: Organic manures, Inorganic fertilizers, RDF, FYM, Vermicompost

Introduction
Garlic (*Allium sativum* L.) belonging to Alliaceae family [1] is an aromatic herbaceous annual spice having 2n =2X=16 with umbellate inflorescence. Garlic has been used in China and India for more than 5000 years, and Egypt since 2000 B.C. (Kamenetsky and Rabinowitch, 2001) [2]. Garlic is the most important *Allium* crop and ranks second next to onion in the world (Voigt, 2004) [3]. It is popular all over the world as a valuable spice and a popular remedy for various diseases. The important garlic growing countries in the world are China, Turkey, Spain, India, Thailand, Korea Republic, Egypt etc. In India and other Asian and Middle–East countries, it is already being used in several food preparation like making of chutneys, pickles, curry powders, curried vegetables, meat preparation and tomato ketchup etc. It is rich in proteins, phosphorus, calcium, magnesium and carbohydrates. According to Unani and Ayurvedic medicines, in the treatment of diseases like chronic infection of stomach and intestine, dysentery, typhoid, cholera and diseases of lungs, garlic is successfully used (Chopra *et al.*, 1958) [4]. At present time garlic tablets are being used worldwide for its hypocholesterolemic action for reducing the cholesterol level in human blood (Augusti, 1977) [5]. Garlic possesses insecticidal action with toxicity of garlic oil to different types of insects. Extract of garlic along with chilli and ginger has beneficial action against many fungi and bacteria.

India has 1252 m t production from 231 m ha area with average productivity of 5.4 t/ha. Among the different states of India, Madhya Pradesh is the leading one accounting for 60 m ha area and 270 m t production. The other major garlic growing states are Gujarat (35 m ha area and 250 m t production) followed by Rajasthan, Uttar Pradesh, Maharashtra and Tamil Nadu. Punjab has highest per hectare yield (12.16 t/ha) followed by West Bengal and Maharashtra [6].

A desire and deserving need of concentrating the sound research work for this crop is required with a complete package of practices i.e. optimum doses of manures and fertilizers to supply major and micro nutrients, proper irrigation techniques, cultural practices and control of various pests and diseases etc. Out of these factors associated with increasing the production of garlic, a sound fertilizer management plays an important role for its good growth, yield and quality. The main way of increasing production of any crop depends on soil conditions and improved production technology. Indiscriminate use of inorganic fertilizers is believed to cause deterioration of soil texture, structure, hindrance of microbial activities, ground water pollution and finally decreased soil fertility and production. On the other hand, the use of organic manures improve soil texture, structure, humus, colour, aeration, water holding

capacity, microbial activities, nutrient use efficiency and thereby increase production and reduce environmental hazards (Pare *et al*., 2000) [7]. Therefore, Integration of organic and inorganic fertilizers can be advocated as one of the strategic solutions to maintain soil fertility and to increase production. Also, it becomes essential to find out the optimum dose of organic manures and inorganic fertilizers combination for proper growth and development of crop. Keeping in view the above facts and for enhancing the growth and yield of garlic in Kanpur (U.P.) conditions, an experiment was conducted at Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during Rabi season of the year 2016 -17.

Materials and Methods

Description of the experimentalsite

The experiment was conducted at Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.). Geographically, Universityis located at $25.26^0$and 26.58^0 North latitude and 79.31^0 and 80.34^0East longitude at an elevation of 127 meters above mean sea level.The climatic conditions of this tract is semi to subtropical with extremes of weather, consisting ofhot dry summer and cold winter season. This region experiences maximum temperature ranging from 40^0 to 45^0C during summer season, while minimum temperature falls down below 7^0Cduringthe winter season. The frost occassionally occurs in month of December – February. The meteorological data during the investigation period (2016-17) were obtained from the meteorological observatory located at Student's Instructional Farm, CSAUA&T, Kanpur. The soil of experimental plot was sandy loam in texture with good organic matter content, slightly acidic in nature and well drained.

ExperimentalMaterials

Healthy Improved White Local genotype having uniform size of cloves were collected from regional market and cloves were planted with spacing of 15 X 10 cm on 25th October 2016. The organic manures and inorganic fertilizers i.e. FYM and Vermicompost, Urea, DAP and MOP were collected from the local market for the experimentation.

Experimental Design and Treatments

Ten treatments were compared in a Randomized Block Design with three replications viz. (1) Unfertilized plot (control)- T_0 (2) 100 % RDF(120 kg/ha N_2 + 60 kg/ha P_2O_5 + 100 kg/ha K_2O)- T_1 (3) 30 t/ha FYM- T_2 (4) 8 t/ha Vermicompost- T_3 (5) 50% RDF + 15 t/ha FYM- T_4 (6) 50% RDF + 4t/ha Vermicompost- T_5 (7) 15 t/ha FYM + 4 t/ha Vermicompost- T_6 (8) 50% RDF + 7.5t/ha FYM +2 t/ha Vermicompost- T_7 (9) 25% RDF + 15 t/ha FYM +2t/ha Vermicompost- T_8 (10) 25% RDF + 7.5 t/ha FYM + 4t/ha Vermicompost-T_9.

Cultural operations

Pre-planting irrigation was done manually with the help of tube well. The experimental field was ploughed and well harrowed by means of tractor operated harrow and cultivator. After land preparation, the experimental field was laid out manually as per the experimental plan with the help of rope and measuring tape keeping a plot size of 2m X 1.5m. Manures and fertilizers were applied as per the treatments. Cloves were planted on 25th October, 2016. The cloves were planted at a spacing of 10 cm apart in each row and a distance of 15 cm was maintained between the rows. Weed control was done manually by hoeing and shallow earthing up. Top dressing of rest dose of nitrogen was done 30 days after planting. Other crop management practices were done as per the requirements after plant emergence. Tagging and measurement of observations was done manually starting from 25th December, 2016 onwards. Harvesting of mature bulbs was done when the top leaves turned yellow and brownish, showing signs of drying up and bending. Garlic plants were harvested manually on 5th April, 2017.

Data collection and measurement:

Five randomly selected competitive plants from each plot were tagged for recording of the various observations on growth, yield and yield attributing characters in garlic. The Plant growth parameters *viz.* plant height, plant diameter, number of leaves per plant, length of longest leaf and width of longest leaf were recorded at 60 days and 90 days after planting. Similarly, yield and its attributing parameters *viz.*weight of bulb, length of bulb, diameter of bulb, number of cloves per bulb, length of longest clove, weight of single clove, bulb yield per plot and bulb yield per ha were recorded after the harvesting of garlic.The data obtained were processed statististically to determine the effect of various treatments.

Results and Discussions

The application of different doses of organic manures and fertilizers significantly improved the vegetative growth parameters of garlic (Table-1). Maximum plant heights, 41.65 cm and 70.64 cm were recorded at 60 DAP and 90 DAP of crop growth with T_1 which was at par to the treatments T_5 and T_7. These findings are in close conformity with the findings of Assefa *et al.* (2015) [8] and Kandil *et al.* (2012) [9]. The maximum plant diameter at 60 DAP (0.84 cm) was obtained with T_1 treated plot, whereas, T_7 treatment had maximum plant diameter at 90 DAP (1.09 cm). Results of experiment can be explained by correlating the observations with the work done by Sevak *et al.* (2012) [10] and Bagali *et al.* (2012) [11]. The maximum number of leaves per plant at 60 and 90 DAP was recorded in the treatment T_7 (7.46 and 11.25 respectively). Similar results were obtained by Suthar (2009) [12], Damse *et al.* (2014) [13] and Chavan *et al.* (2016) [14].The length of longest leaf at 60 DAP as well as at 90 DAP was maximum with the application of T_1 followed by length at 60 DAP in T_5 (37.87 cm) and length at 90 DAP in T_7 (68.54 cm). Similar results regarding leaf length were reported by Suthar (2009) [12] in garlic and Singh *et al.* (2015) [15] in onion. The width of longest leaf at 60 DAP was maximum with the application of T_1 (1.38 cm) followed by T_7 (1.31 cm). Whereas, at 90 DAP, plot treated with treatment T_7 had maximum width of longest leaf (1.88 cm) followed by T_1 (1.86 cm). These findings are in very close conformity with the findings of Malatu *et al*. (2014) [16].

Similarly, there was a significant increase in the yield andits attributing parameters (Table-2). T_7 produced maximum weight of bulb (39.68 g) which was at par with the treatments T_1 and T_5. These findings are in close conformity with the findings of Bagali *et al*. (2012) [11] and Singh *et al.,* (2015). The maximum length of bulb after harvesting (5.24 cm) was noted with the treatment T_7 followed by treatment T_2. Similar results were also obtained by Bhandari*et al.* (2012) [17] and Damse *etal.* (2014)[13] while working on integrated nutrient management in garlic by using organic manures in combination with inorganic fertilizers and biofertilizers. The

maximum diameter of bulb (5.03 cm) was recorded with the application of T_7 followed by treatment T_1, T_5 and T_9. Similar findings on diameter of bulb were reported by Bhandari *et al.*(2012) [17] and Bagali *et al.* (2012) [11]. Maximum number of cloves per bulb (27.63) was recorded with T_7 followed by T_5. Singh *et al.* (2015) [15] and Assefa *et al.* (2015) [8] also reported such type of results on number of cloves per bulb with the application of inorganic fertilizer along with FYM and Biofertilizers. Length of longest cloves of bulb was maximum (3.82 cm) in treatment T_7. Similar findings were reported byDamse *etal.* (2014)[13] andBhandari *et al.* (2012) [17] who reported the key role of integration of organic manures, inorganic fertilizers and biofertilizers for improvement in the crop yield. The maximum weight of single clove (1.52 g) was recorded with the application of T_7 followed by T_9 having 1.47 g weight of single clove. Similar results for weight of clove were found by Sevak *et al.* (2012) [10]. The maximum bulb yield per plot (4.66 kg) was found in the treatment T_7 followed by T_5 and T_9 having 4.26 kg and 4.23 kg bulb yield per plot respectively. These findings also confirm the results of Sevak *et al.* (2012) [10] and Singh *et al.* (2015) [15]. The bulb yield per ha was significantly affected by different treatment combinations. The maximum bulb yield per ha (155.48 q) was found under treatment T_7 followed by T_5 and T_9 having 142.17 q and 141.01 q bulb yield per ha respectively. In the present study, the bulb yield per plot was significantly enhanced due to interaction effects of RDF, FYM, and Vermicompost. Similar results were reported by Yoldas *et al.*(2011) [18],Bagali *et al.* (2012) [11],Bhandari *et al.* (2012) [17],Damse *et al.*(2014)[13]and Singh *et al.* (2015) [15].

Table 1: Effect of different doses of organic manures and inorganic fertilizers on Growth parameters of Garlic

S.No.	Treatments	Plant height (cm)		Plant diameter (cm)		No. of leaves per plant		Length of longest leaf (cm)		Width of longest leaf (cm)	
		60 DAP	90 DAP	60 DAP	90 DAP	60 DAP	90 DAP	60 DAP	90 DAP	60 DAP	90 DAP
1	T_0	26.48	43.40	0.48	0.82	5.63	7.67	26.35	40.36	0.80	1.43
2	T_1	41.65	70.64	0.84	1.06	7.31	9.72	41.07	69.47	1.38	1.86
3	T_2	31.08	52.51	0.60	0.98	6.68	8.87	30.96	50.03	0.99	1.53
4	T_3	33.13	55.36	0.73	1.01	7.03	9.17	32.95	53.12	1.13	1.65
5	T_4	34.78	57.84	0.77	1.08	7.06	9.70	34.27	56.20	1.03	1.70
6	T_5	40.91	65.56	0.80	1.08	7.20	10.37	37.87	61.92	1.00	1.71
7	T_6	40.31	67.61	0.66	1.03	7.15	9.82	32.41	65.16	1.01	1.66
8	T_7	39.92	69.56	0.73	1.09	7.46	11.25	37.15	68.54	1.31	1.88
9	T_8	35.55	55.63	0.70	0.98	6.71	10.58	32.26	53.40	1.03	1.72
10	T_9	35.56	56.18	0.75	0.97	6.93	10.25	31.62	53.42	0.94	1.76
	SE(m)	1.021	1.043	0.010	0.029	0.092	0.22	0.721	0.767	0.035	0.025
	CD at 5%	3.056	3.122	0.029	0.087	0.275	0.68	2.159	2.296	0.104	0.075

Note:DAS = Days After Sowing

Table 2: Effect of different doses of organic manures and inorganic fertilizers on Yield and its attributing parameters of Garlic

S. No.	Treatments	Wt. of bulb (g)	Length of bulb (cm)	Diameter of bulb (cm)	No. of cloves per bulb	Length of longest clove (cm)	Wt. of single clove (g)	Bulb yield per plot (kg)	Bulb yield per ha (q)
1	T_0	20.05	3.89	3.80	17.15	2.94	0.99	2.26	75.37
2	T_1	38.37	5.04	4.97	26.31	3.33	1.46	4.06	135.51
3	T_2	26.90	4.16	4.04	23.87	3.10	1.26	3.05	101.61
4	T_3	33.25	4.73	4.26	24.67	3.46	1.33	3.81	127.17
5	T_4	34.84	4.45	4.25	24.63	3.23	1.40	3.91	130.30
6	T_5	37.10	5.07	4.93	26.67	3.60	1.46	4.26	142.17
7	T_6	32.92	4.39	4.03	23.70	3.16	1.27	3.61	120.48
8	T_7	39.68	5.24	5.03	27.63	3.82	1.52	4.66	155.48
9	T_8	32.02	4.73	4.44	23.31	3.44	1.39	3.95	131.64
10	T_9	34.23	5.07	4.70	23.83	3.65	1.47	4.23	141.01
	SE(m)	0.633	0.052	0.112	0.558	0.064	0.034	0.09	2.95
	CD at 5%	1.895	0.157	0.336	1.671	0.191	0.103	0.26	8.85

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