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Short Communication

Effect of Integrated Nutrient Management on Yield and Quality of Garlic cv. Yamuna Safed-3

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ABSTRACT

An experiment was conducted at Horticultural Research Centre, SVP University of Agriculture and Technology, Meerut (UP) during *Rabi* season of 2018-19 to assess the impact of different INM doses on yield and quality parameters of garlic. A total of ten treatments consisting of combinations of inorganic fertilizers, organic fertilizers and bio-fertilizers like T_1- (Control), T_2RDF (100:50:50 kg NPK ha^{-1}), T_3-RDF + 20 kg sulphur + FYM 20 ton ha^{-1}, T_4-RDF + 20 kg sulphur + VC 4 ton ha^{-1}, T_5- 75% RDF + 40 kg sulphur + 5 ton FYM ha^{-1}+ PSB 5 kg ha^{-1}, T_6-75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}, T_7- 75% RDF + 40 kg sulphur + FYM 3 ton + VC 1 ton+ PSB 5 kg + Azotobacter 5kg ha^{-1}, T_8- 50% RDF + 40 kg sulphur + FYM 5 ton + VC2 ton + PSB 5 kg ha^{-1}, T_9- 50% RDF + 40 kg sulphur + FYM5 ton + VC 2 ton+ Azotobacter 5 kg $ha^{-1}$and T_{10}- 50% RDF + 40 kg sulphur + FYM 5 ton + VC2 ton + PSB 5 kg + Azotobacter 5 kg ha^{-1} were used in Randomized Block Design and replicated thrice. Out of these an application of T_7 (75% RDF + 40 kg sulphur + FYM3 ton + VC 1-ton ha^{-1} + PSB 5 kg + Azotobacter 5 kg ha^{-1}) was found to be significantly superior in term of yield and attributing parameters of garlic.

KEYWORDS

Garlic, INM, Yield, Quality and Yamuna Safed-3

Garlic (*Allium sativum* L.) belongs to the family Alliaceae. It is considered as a spice crop. In India, it is commonly known as *Lahsun*. The primary centre of origin of garlic is Central Asia and Southern Europe and secondary centre is Mediterranean region (Heever, 2006). Garlic has higher nutritive value and is commonly consumed as flavouring foods, preparing chutneys, pickles, curry powder, tomato ketchup etc. It is a rich source of volatile components mainly consisting of sulphur compounds that are responsible for the strong odour, flavor/aroma and pungency (Salomon, 2002). The pungency, strong flavor and keeping quality of garlic is mainly due to the abundant quantity of diallyl disulphide content (Rai and Yadav, 2005). Due to its pungency, it possesses strong insecticidal property. It contains considerable amounts of calcium, phosphorous and potassium and its leaves are good source of protein, vitamin A and C. Garlic is very helpful to control heart and blood system like high blood pressure, low blood pressure, high cholesterol, inherited high cholesterol, coronary heart disease, heart attack, reduced blood flow due to narrowed arteries, and " Hardening of the Arteries"Garlic therapy has also been suggested in flatulence, constipation, faulty digestion, inadequate food intake, chronic coughs, leprosy and many other diseases (Adegoke *et al.*, 1998).

Garlic is well grown in worldwide and some major producing countries like China, South Korea, Russia, Burma, Ukraine and Brazil. China is produces 75% of garlic production and has first rank in production in world. In India, garlic is grown in an area of 274 thousand hectares with an annual production of 1.27 million tones. Madhya Pradesh is the leading state accounting for 60.00 thousand hectares area and 405.0 thousand tons of production contributing 21.9% of area and 31.89% in production of country's total. Beside this other major garlic producing states are Rajasthan, U.P., Gujarat and Punjab. The productivity of this crop is quite low i.e. 5.29 t ha^{-1} which is far less than that of China and Egypt. This may be led to unscientific cultivation, improper use of manures and fertilizers application, old varieties etc. (Anonymous, 2017).

The high productivity of crop plant may vary judicious use of nutrient at optimum level. Plant nutrients play a vital role in growth; yield and quality of crop production. Nutrients play an important role in internal metabolic activities in plant body. It is well known fact that inorganic fertilizers application leads harmful effect on soil fertility resulting poor yield and quality. Therefore, integration of chemical fertilizers, organic manures and biofertilizers are able to maintain the good soil health, productivity and fertility status of soil (Jeyabal *et al.*, 2000). Similarly, an increase in Sulphur containing product makes availability all in content in leaves and bulbs of (Heever; 2006). The major nutrient like nitrogen is necessary for ensuring good vegetative growth of garlic (Kakara *et al.*, 2002). Biofertilizers are known to play an important role in increasing availability of nitrogen and phosphorus besides improving biological fixation of atmospheric nitrogen and produce hormones and anti-metabolites (Bhat *et al.*, 2013). The role of farm yard manure in enhancing efficient use of chemical fertilizers is well documented. The FYM, nitrogen, phosphorus, potassium and its combination and comparison with biofertilizers are used in integrated manner resulting to achieve optimum bulb yield of garlic. Similarly, vermi compost is superior to most compost as inoculants in the production of compost. It restores the microbial population

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which includes nitrogen fixers, phosphate solubilizers, provided major and micro nutrients, improve aeration, water holding capacity etc. Keeping the above facts that an experiment entitled "Effect of integrated nutrient management on growth characters of garlic (*Allium sativum* L.) c.v. Yamuna Safed-3" was carried out during the *Rabi* season of 2018-19.

The experiment was conceded out at Horticulture Research Center (HRC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut (Uttar Pradesh) during *Rabi* season of 2018-19. The present experiment was laid out in Randomized Block Design with and replicated thrice. Total ten treatments include different combinations of inorganic fertilizers, organic fertilizers and bio-fertilizers likeT_1- (Control), T_2RDF (100:50:50 kg NPK ha^{-1}), T_3-RDF + 20 kg sulphur + FYM 20 ton ha^{-1}, T_4- RDF + 20 kg sulphur + VC 4 ton ha^{-1}, T_5- 75% RDF + 40 kg sulphur + 5 ton FYM ha^{-1}+ PSB 5 kg ha^{-1}, T_6-75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}, T_7- 75% RDF + 40 kg sulphur + FYM 3 ton + VC 1 ton+ PSB 5 kg + Azotobacter 5kg ha^{-1}, T_8- 50% RDF + 40 kg sulphur + FYM 5 ton + VC2 ton + PSB 5 kg ha^{-1}, T_9- 50% RDF + 40 kg sulphur + FYM5 ton + VC 2 ton + Azotobacter 5 kg $ha^{-1}$and T_{10}- 50% RDF + 40 kg sulphur + FYM 5 ton + VC2 ton + PSB 5 kg + Azotobacter 5 kg ha^{-} The soil of experimental plot was sandy loam with pH (7.43), available nitrogen (153.35 kg/ha), available phosphorus (23.74 kg/ha), available potassium (121.47 kg/ha) and available sulphur (18.98 kg/ha).

A defined schedule of application of manure and fertilizers were adopted w.e.f., sowing to growth of crop. The full dose of well rotten FYM was supplied in field before two weeks of planting of cloves for better mineralization of farm yard manure, while vermicompost and biofertilizers were added in soil prior to planting of cloves. The half dose of nitrogen and full doses of phosphorus and potassium were also applied before sowing of cloves and remaining half dose of nitrogen was applied in standing crop in two equal split doses at 30 and 45 days after planting of cloves. The observation in growth parameters like plant height, number of leaves per plant, length of longest leaf, leaf width, collar height, collar width, fresh weight of plants, dry weight of plants, dry matter content of plants and days to maturity were recorded during the course of investigation. The data were statistically analyzed by Panse and Sukhatme (1989).

The various quality, and yield attributing characters of garlic were found significantly differ amongst the applied treatments. It was noted that a certain dose of INM application gave significantly superior effect in terms of yield and quality parameters as compare to control and other treatments.

Results indicated that the maximum length of bulb (4.59 cm) was recorded in application of T_7- (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB + Azotobacter 5 kg ha^{-1}) followed byT_6- (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1} i.e., 4.35 cm, while minimum length of bulb (3.49 cm) was observed with control followed by T_8 (50% RDF + 40 kg sulphur + 5 ton FYM + 2 ton VC + PSB 5 kg ha^{-1}) i.e., 3.53 cm. Similarly, maximum diameter of bulb (5.40 cm) was recorded in T_7- (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}), while lowest diameter of bulb (3.29 cm) was noted under control plots. The beneficial effect in terms of length and diameter might be due supply of nutrients at optimum level leading to accumulation of carbohydrates in ultimate produce by proper photosynthesis in leaves. These results were in agreement with the findings of (Mankar, 2005) and (Hore *et al*., 2014). On other hand, the number of cloves and weight of cloves as affected by INM treatments were differed significantly among the treatments. The greatest number of cloves (28.23) was observed with an application of treatment T_7 (75% RDF + 40 kg sulphur + 3ton FYM + 1ton VC + PSB 5kg + Azotobacter 5 kg ha^{-1}) followed byT_6 (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}) i.e., 25.00 as compared to control (14.90) followed byT_8 (50% RDF + 40 kg sulphur + 5 ton FYM + 2 ton VC + PSB 5 kg ha^{-1}) i.e., 16.03. The

Table 1: Effect of integrated nutrient management on yield and quality of garlic (*Allium sativum* L.)

Treatments	Length of bulb (cm)	Diameter of bulb (cm)	No. of cloves $Bulb^{-1}$	Wt. of cloves (g)	Length of coves (cm)	Width of cloves (cm)	Wt. of Bulb (g)	Yield (q ha^{-1})	Moisture Content (%) in bulbs	TSS (^{0}Brix)	Ascorbic Acid (mg/100 g)
T1 Control	3.49	3.29	14.90	1.07	2.49	0.59	17.90	81.80	57.07	37.93	12.04
T2	3.79	4.70	20.68	1.30	3.23	0.81	34.07	121.80	59.60	38.36	13.17
T3	4.07	4.85	22.27	1.42	3.40	0.85	37.07	127.60	60.16	38.49	13.44
T4	4.15	4.86	23.37	1.51	3.46	0.91	43.37	137.07	60.60	38.62	13.70
T5	4.20	4.87	25.00	1.54	3.62	0.93	45.67	126.20	61.14	38.75	13.86
T6	4.35	5.09	26.43	1.62	3.80	0.98	46.97	139.27	61.41	39.13	14.00
T7	4.59	5.40	28.23	1.75	4.07	1.30	50.23	158.93	62.62	39.68	14.28
T8	3.53	3.84	16.03	1.17	3.07	0.67	22.60	117.20	58.14	38.13	12.76
T9	3.59	4.13	17.37	1.16	2.73	0.64	26.80	114.87	57.82	38.02	12.43
T10	3.75	4.55	19.23	1.23	3.19	0.73	31.57	118.87	58.75	38.23	12.94
CD (P=0.05)	**1.11**	**0.06**	**0.60**	**0.06**	**0.20**	**0.09**	**1.94**	**2.42**	**0.22**	**0.09**	**0.13**

maximum weight of per cloves (1.75 g) was recorded with a dose of T_7 (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}). However, minimum weight of per cloves (1.07 g) was recorded under the treatment T_1 (control). The maximum number of cloves may be enhanced due toproper application of different sources of nutrients. Similarly, the increased weight of per clovesmight be due to higher accumulation of carbohydrates as stored food and sulphur is also responsible for gaining weight of cloves. These findings were close in conformity with findings of (Naruka *et al.,* 2005) and (Sachin *et al.,* 2017).

In context of length and width of cloves, the maximum length of cloves i.e. 4.07 cm and width of clove i.e., 1.30 cm were measured in the treatment T_7 75 % RDF + 40 kg Sulphur + 3t FYM + 1t VC + PSB 5 kg and Azotobacter 5 kg ha^{-1} followed by treatment T_6 (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}) i.e., 3.80 and 0.98 cm (45.60 cm), whereas the minimum length of cloves (2.49 cm) and width of clove (0.59 cm) were measured in the treatment T_1 (Control).The increased length and width of cloves may be due to enhanced availability of nutrients and production of promoting substances by the balanced fertilization of nutrient sources that might have caused cell elongation and cell multiplication. These results are in conformity with the finding of Ranjan *et al.* (2010) and Sachin *et al.* (2017).

Maximum weight of bulb (50.23g) was received when plants fertilized with an application of treatment T_7- (75 % RDF + 40 kg Sulphur + 3ton FYM + 1ton VC + PSB 5 kg and Azotobacter 5 kg ha^{-1}) followed by T_6 (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}) i.e., 46.97g. Moreover, the minimum weight of bulb (17.90g) was recorded under the treatment like control (T_1). In context of yield of marketable bulb of garlic was also affected in significant manner as application of various INM treatments. The maximum yield of bulb (158.93 qha^{-1}) was received from the plot fertilized with treatment T_7 (75 % RDF + 40 kg Sulphur + 3ton FYM + 1ton VC + PSB 5 kg and Azotobacter 5 kg ha^{-1}) followed by T_6 (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}) i.e., 139.27 qha^{-1} during experimentation. However, minimum yield of bulbs (81.80 qha^{-1}) was obtained under the control treatment (T_7). The significant improvement in bulb yield is might be due to the application of source of nutrients in integrated manner viz, organic, inorganic and biofertilizers combinations. The INM dose with using inorganic, organic manure like FYM and vermicompost and abundant quantity of azotobacter and PSB improves physical and chemical properties of soil, resulting better mineralization of organic manures and adding nitrogen in soil by azotobacter thus makes availability of nutrients more to the plants. Similarly, PSB improves the availability of phosphorus in abundant quantity in soil and more uptake by feeding roots. Such beneficial effects have been well established by the earlier findings of Islam *et al.* (2007), Patidar *et al.* (2017) and Singh *et al.* (2017).

The quality parameters like moisture content (%), TSS (^{0}Brix) and ascorbic acid (mg/100g) were significantly affected by various doses of INM during the experimentation. The quality parameters improve with using RDF to 75% of RDF doses with combinations of sulphur, FYM, Vermicompost, PSB and azotobacter then declined the quality parameters when reduced upto 50% of RDF with combinations of sulphur, FYM, Vermicompost, PSB and azotobacter in the present experiment. The lowest moisture content, TSS and ascorbic acid were found under the control.

The highest moisture content (62.62%) was found in treatments like T_7 (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}) followed byT_6 (75% RDF + 40 kg sulphur + 2 ton VC + Azotobacter 5 kg ha^{-1}) i.e., 61.14%. However, minimum moisture content (57.07%) was recorded under the control followed by T_{10} (50% RDF + 40 kg sulphur + 5 ton FYM + 2 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}). This kind of things in relation to moisture content in bulb might be due to assimilation of higher content of nutrients supplied by the sources of nutrients in terms of nitrogen, phosphorous, sulphur and biofertilizers plays an important role in increase in growth, succulence and turgidity in cells. The results are in close conformity with earlier findings given by (Patil *et al.,* 2007) and (Islah, 2010). Similar kinds of results were also obtained in terms of TSS content in garlic bulbs in significant trends. The maximum TSS (39.68^0 Brix) was pragmatic under the treatment applied asT_7 (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}), while lowest TSS (37.93 ^{0}Brix) was recorded with the control (T_1). Improvement in total soluble solids in garlic might be due to the optimum availability of nutrient like NPK and sulphur with addition of organic manures to deposition of carbohydrates, protein etc. These results are close in agreement with earlier findings of (Sevak *et al.,* 2012) and (Patidar *et al.,* 2017). Another quality parameter like ascorbic acid was also influenced with using various INM doses in positive way in garlic. The maximum ascorbic acid (14.28 mg/100g) of garlic was found with an application ofT_7 (75% RDF + 40 kg sulphur + 3 ton FYM + 1 ton VC + PSB 5 kg + Azotobacter 5 kg ha^{-1}) and minimum ascorbic acid (12.04mg/100g) was determined under control (T_1). The higher amount of ascorbic acid in garlic may be due to the internal enzymatic activities and sufficient food stored in bulbs. It was found due to the physiological, chemical and biological activities in soil strata with using organic, inorganic and biofertilizers sources of nutrients for integrated manner. Similar results were also obtained by (Naruka *et al.,* 2005) and (Waghachavare, 2004) in bulbous vegetables.

Based on above findings that application of –75:25:25 kg NPK + 40 kg sulphur + 3 ton FYM + 1 ton VC ha^{-1}+ PSB 5 kg + Azotobacter 5 kg $ha^{-1}$was found to be significantly superior in term of yield and quality of garlic. It is concluded that the above dose of INM was found most efficient to the vegetable's growers of Western Uttar Pradesh.

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