The Bioscan 9(4): 1557-1560, 2014
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF GARLIC

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KEYWORDS
Integrated
Nutrient Management
Garlic

Received on :
14.07.2014

Accepted on :
07.10.2014

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ABSTRACT

An experiment on integrated nutrient management in Garlic was conducted. Among treatments, T_6 (75:40:40:40 kg NPKS + 7.5t FYM + 3.75t Poultry manure ha^{-1}) was found superior in respect of bulb yield (150.41 q ha^{-1}) and benefit cost ratio 1.68 followed by treatment T_5 (75:40:40:40 kg NPKS + 7.5t vermicompost ha^{-1}) (144.00 q ha^{-1}) for all three seasons; whereas, T_1 and T_2 shown 132.08 q ha^{-1} and 130.19 q ha^{-1} yield. Thus, application of reduced dose of chemical fertilizers along with combination of two or three organic manures was found beneficial for garlic in *rabi* season.

INTRODUCTION

Garlic (*Allium sativum* L.) belonging to family Alliaceae is the second important bulb crop after onion, widely used in flavouring of food, preparation of chutneys, pickles, curry powder, tomato ketch-up etc. Besides nutritive values, it is included in Indian system of medicines (Ayurvedic, Unani and Siddha) as a carminative and gastric stimulant to help digestion and absorption of food (Sankaracharya, 1974). India ranked second in area and production of garlic in the world. The productivity of this crop is quite low i.e. 5.27 t ha^{-1} (Anonymous, 2011) which is far less than that of China and Egypt. This may be due to its unscientific cultivation particularly nutrient management. The sexual sterility of garlic limits genetic yield potential of garlic varieties hence, it is necessary to get maximum yield from available genotypes to meet increasing demand for this crop. It has to be attained by increasing the productivity per unit area through judicious and efficient management of soil, water and fertilizers. Main objective of organic farming is to create a balance between soil organisms, plants, animals and humans. Organic manures are responsible for improving chemical, physical and physiochemical properties of soil. For obtaining higher yield in vegetable crops excessive amounts of inorganic fertilizers are applied (Stewart *et al.*, 2005). The excessive use of chemical fertilizer resulted in deficiency of nutrients other than applied and caused decline in organic carbon in the soil (Singh *et al.*, 2001). Also, use of only inorganic fertilizers is detrimental to human health and the environment (Arisha and Bardisi, 1999). Organic manure is alternative practice to mineral fertilization (Naeem *et al.*, 2006). It helps in improving soil structure (Dauda *et al.*, 2008) and soil biomass (Suresh *et al.*, 2004). Organic manure improves soil structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity, which results in availability of micronutrients available to plants (Zeidan, 2007). (Talware *et al.*, 2012) reported maximum growth and yield in garlic with the application of reduced dose of fertilizers along with the application of FYM and biofertilizers under Gujarat condition. Considering these results challenge is to combine organic manures of different quality with chemical fertilizers to optimize nutrient availability to garlic for better yield and quality of bulb. Keeping this in view, the present investigation was carried out to verify the impact of nutrient management on production of Garlic.

MATERIALS AND METHODS

Experiment was conducted during *rabi* 2010-11, 2011-12 and 2012-13 in three replications consisting of nine treatments with Randomized Block Design at AICRP on Vegetable Crops, Dept. Horticulture, MPKV, Rahuri, Dist-Ahmednagar (M.S.) INDIA as a part of All India Network Research Project on Onion and Garlic and suggested methodology to carry out the experiment (Anonymous, 2010 and Gowda *et al.*, 2007). Plot size was kept at 3m x 2m and spacing was maintained at 15cm x 10 cm. big size cloves were selected for planting. Treatments were as mentioned in table.1. Biofertilizer (*Azospirillum* and Phosphorus Solubilizing Bacteria (PSB) @ 5 kg each/ha) applied to all nine treatments. Fifty percent N was applied as basal at the time of planting and remaining 50% N was applied in two equal splits during 30 and 45 days after planting; full dose of P and K was applied at the time of

Table 1: Treatment details

Treatments	Treatment Details	
T1	100:50:50 kg NPK + 20t FYM ha^{-1} (MPKV, Rahuri. recommendation	+ Biofertilizer (*Azospirillum* and Phosphorus Solubilizing Bacteria (PSB) @ 5 kg each/ha)
T2	100:50:50:50 kg NPKS + 20t FYM ha^{-1} (DOGR, Rajgurunagar, Recommendation	
T3	75:40:40:40 kg NPKS + 15t FYM ha^{-1}	
T4	75:40:40:40 kg NPKS + 7.5t PM ha^{-1}	
T5	75:40:40:40 kg NPKS + 7.5t VC ha^{-1}	
T6	75:40:40:40 kg NPKS + 7.5t FYM + 3.75t PM ha^{-1}	
T7	75:40:40:40 kg NPKS + 7.5t FYM + 3.75t VC ha^{-1}	
T8	75:40:40:40 kg NPKS + 3.75t PM + 3.75t VC ha^{-1}	
T9	75:40:40:40 kg NPKS + 5t FYM + 2.5t PM + 2.5t VC ha^{-1}	

Table 2: Yield and ancillary performance of garlic (pooled results of three years).

Treatments	Yield q ha^{-1}			Mean yield	Plant height (cm)	No. leaves	Equatorial diameter (cm)	Polar diameter (cm)
	2010-11	2011-12	2012-13					
T1	141.27	129.26	125.72	132.08	58.49	11.44	3.83	3.05
T2	147.72	122.57	120.28	130.19	61.43	11.47	3.79	2.97
T3	139.38	122.51	126.89	129.59	59.71	11.11	3.72	2.98
T4	119.49	127.89	129.83	125.74	60.04	11.13	3.56	2.78
T5	146.77	145.23	140.00	144.00	59.22	11.73	3.66	2.89
T6	163.10	141.20	146.94	150.41	60.13	12.11	3.72	3.00
T7	147.38	137.12	121.22	135.24	59.55	11.54	3.75	2.92
T8	145.72	140.94	124.39	137.02	59.80	11.11	4.01	3.00
T9	159.10	135.82	124.72	139.88	60.38	11.40	3.99	3.07
S.E.+	9.49	12.38	6.36	4.51	1.25	0.32	0.10	0.05
C.D. at 5%	28.22	37.11	19.07	13.54	3.75	0.98	0.32	0.17

Table 2: Cont....

Treatments	Neck Thickness(cm)	Av. bulb weight (g)	Nutrient Uptake (Kg ha^{-1})			
			N	P	K	S
T1	0.68	23.89	121.29	30.06	125.81	27.54
T2	0.75	21.74	135.35	32.63	129.39	30.48
T3	0.70	21.69	126.24	27.33	127.08	28.22
T4	0.67	23.00	108.95	27.40	107.04	28.18
T5	0.69	23.73	137.77	33.67	137.44	32.39
T6	0.70	24.27	151.10	39.96	150.17	37.13
T7	0.69	23.80	133.53	35.68	135.52	35.06
T8	0.69	24.16	147.11	37.96	138.78	33.69
T9	0.69	24.60	143.10	37.67	150.81	36.94
S.E.+	0.03	0.90	16.41	3.39	9.44	2.42
C.D. at 5%	0.10	2.72	49.20	10.18	28.31	7.27

planting and full dose of S was given fifty days before planting as per treatments. All organic manures (FYM, PM, VC and both Biofertilizers were applied as a basal dose. Garlic crop was harvested when tops turned yellow to light brown showing the sign of drying. As per this method observations recorded were plant height, leaf length, leaf width, number of leaves, polar diameter of bulb, equatorial diameter of bulb, average bulb weight, A, B, C grade bulb percentage, marketable bulb yield, total yield storage losses, nutrient uptake kg ha^{-1} and economics was worked out for each plot. The data were analyzed statistically and results were interpreted by using methods suggested by (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

As per three years ancillary data, performance of garlic was greatly influenced by different treatments. Plant height and bulb neck thickness was non-significant, while significantly highest number of leaves (12.11) was shown by treatment T_6 (75:40:40:40 kg NPKS + 7.5t FYM + 3.75t PM ha^{-1}) however, remaining treatments were at par (Table 2). These vegetative characters are primary characters which decide vigour of the crop and influence on yield through enhanced dry matter production. Enhanced plant growth characters might be due to higher nutrient availability as well as better nutrient uptake by the crop (Pitchai *et al.,* 2001). Major nutrient supplied by the inorganic fertilizers will be utilized quickly by the crop and all other micro and macro nutrients available in organic manures will be released slowly. Hence, combination of these manures helped to increase availability of major nutrients which being the constituent of protein and protoplasm, vigorously inducing the vegetative development of the plants. (Sankar *et al.,* 2005) utilized FYM along with inorganic fertilizers and reported similar results in onion crop. (Kore *et al.,* 2006) reported maximum plant height, number of leaves and yield in treatment having 10 t FYM + 3 kg Azt + 3 kg PSB + 75 % RDF, while studying response of garlic to the

application of organic, inorganic and biofertilizers in various combinations. (Gowda *et al.,* 2007) studied the influence of integrated nutrient management in garlic *cv*. G-282 and observed that; treatment 100 % NPK + Biofertilizer + Vermicompost recorded significantly higher bulb yield, plant height, number of leaves and girth of plant. (Birajdar, 1991) reported that application of 40 tones FYM + 75:50:50 NPK kg ha^{-1} + Biofertilizer in onion showed significant increase in number of leaves per plant. (Jayathilake, 2002) reported the plant height and number of leaves per plant were highest at 100 days after transplanting upon treatment with biofertilizers + 50 % recommended N through organic manures + 50 % N and 100 % P, K through chemical fertilizers in onion crop. (Poopathi, 1994) reported improved cell elongation and cell differentiation results in to increased growth of tomato might be due to higher availability of nutrients and uptake by crop.

The yield contributing characters like bulb equatorial diameter and polar diameter representing average size of bulb were significant. Treatment T_8 recorded highest (4.01cm) equatorial diameter followed by T_9. Highest polar diameter (3.07cm) was recorded by T_9 followed by T_1 and T_6 (Table 2). Significantly highest average bulb weight (24.60 g) was depicted by treatment T_9 followed by T_6 whereas; T_8, T_1, T_7, T_5, and T_4 were at par. It clearly reflects importance of inorganic fertilizers in two or three combinations with reduced dose of organic fertilizers might be due to higher availability of nitrogen, phosphorus, potash and micronutrients in soils as a result of increased decomposition of FYM, vermicompost, and poultry manure effected the continuous slow release of nutrients and biofertilizers viz. *Azospirillum,* PSB also might have contributed by supplying growth promoters (Okon *et al.,* 1985). (Jawadagi *et al*., 2012) reported improvement in bulb weight, bulb diameter and bulb length in treatment having FYM 12.50 t ha^{-1} + VC 2 t ha^{-1} + Biofertilizers in *kharif* onion. (Mamatha, 2006) observed the highest bulb diameter with the application of FYM + vermicompost in onion. (Birajdar, 1991) recorded maximum polar diameter (6.06 cm) and equatorial diameter (6.64 cm) with treatment 40 t FYM + 25:50:50 NPK kg ha^{-1} + Biofertilizers. (Nelson, 1983) reported both yield and bulb size of garlic was improved with the increasing nitrogen rate. In present investigation there was increase in bulb weight due to optimum nutrient supply for bulb development as it was also reported by other workers (Gowda *et al.,* 2007).

During 2010-11 significantly higher yield (163.10 q ha^{-1}) was recorded by treatment T_6 followed by T_9 (159.10 q ha^{-1}) (Table 2). In 2011-12 yield levels were non-significant and in 2012-13 treatment T_6 shown significantly higher yield (146.94 q ha^{-1}) followed by T_5 (140.00 q ha^{-1}). By assessing data of three years, treatment T_6 (75:40:40:40 kg NPKS + 7.5t FYM + 3.75t PM ha^{-1}) recorded significantly higher yield (150.41 q ha^{-1}) followed by T_5 (144.00 q ha^{-1}) (75:40:40:40 kg NPKS + 7.5t VC ha^{-1}) and T_9 (139.88 q ha^{-1}) (75:40:40:40 kg NPKS+5t FYM+2.5t PM + 2.5t VC ha^{-1}) whereas, treatment T_8 (75:40:40:40 kg NPKS + 3.75t PM + 3.75t VC ha^{-1}) was at par. Considering these results combination of organic manures along with reduced dose of fertilizers gives 14-15% increase in yield. This might be due to the fact that organic manure supplied to balanced nutrition to the crop, improved soil condition and thereby resulting in better growth and development leading to higher yield. (Bhagwan Singh Choudhary *et al.,* 2013) recorded maximum garlic bulb yield with 100% RDF + 5.0 t ha^{-1} VC treatment combination. These were at par with 75% RDF + 2.5 t ha^{-1} VC, 75% RDF + 5 t ha^{-1} VC, 75% RDF + 2.5 t ha^{-1} PM, 75% RDF + 5.0 t ha^{-1} PM. The results are in line with those of (Shashidhar *et al*., 2005). These results are in close agreement with those of Gowda *et al,* (2007) reported treatment 100 % NPK + Biofertilizer + Vermicompost recorded maximum bulb yield in garlic. During first year lowest yield was recorded by T_4 (75:40:40:40 kg NPKS + 7.5t PM ha^{-1}), in second year T_3 (75:40:40:40 kg NPKS + 15t FYM ha^{-1}) recorded lowest yield and during last year T_2 (100:50:50:50 kg NPKS + 20t FYM ha^{-1}) recorded least yield. Overall lowest yield was recorded by T_4 (75:40:40:40 kg NPKS + 7.5t PM ha^{-1}) which might be due to adverse effect of poultry manure as (Mountney *et al*., 1983) reported that nitrogen availability of poultry manure is too quick that, if care is not taken, burning occurs. These findings confirming the results of (Mankar *et al*., 2010; Puttaraju, 2010; Gowda *et al*., 2007; Kore *et al*., 2006) reported response of garlic to the application of inorganic, organic and biofertilizer in various combination increase yield ha^{-1}. (Dalal and Nandkar, 2010) reported that combined treatments of biofertilizers and chemical fertilizers showed significant growth and yields over individual and control treatments in *Abelmoschus Esculentus* (L.) (Sharma *et al*., 2013) carried experiment on Integrated Nutrient Management on wheat, the results revealed that the substitution of 25% NPK through farmyard manure in recommended dose of NPK along with 5 kg Zn/ha and PSB + *Azotobactor* recorded significantly higher grain yield (58.23 q/ha) over the 100% NPK treatment (49.79 q/ha).

Maximum N, P, K and S uptake was reported in treatment T_6 (151.10 kg ha^{-1}) followed by T_9 (75:40:40:40 kg NPKS+5t FYM+2.5t PM + 2.5t VC ha^{-1}). An increase in N, P, K, Fe, Mn and Cu contents in faba beans due to the application of poultry manure (Faiyard *et al*., 1991). (Rayar *et al*., 1984) noticed increase in available N when poultry manure; swine manure and FYM were applied to the soil. Maximum B: C ratio (1.68) was recorded with the application of 75:40:40:40 kg NPKS + 7.5t FYM + 3.75t PM ha^{-1}. Lowest B: C ratio was reported by treatment T_4 (75:40:40:40 kg NPKS + 7.5t PM ha^{-1}) in three years. (Bybordi and Malakouti, 2007) and (Sharma *et al*., 2003) realized highest net returns and B: C with the application of FYM and vermicompost in onion. (Basavaraja *et al*., 2007) studied the effect on integrated nutrient management on onion yield and soil properties. The study revealed that combined application of coir pith based on compost @ 15 t ha^{-1} along with press mud (PM) and half the recommended dose of fertilizer gave significant higher bulb yield of onion as compared to RDF along with FYM with better benefit cost ratio. Poultry manure and FYM recorded higher yield of rice and ragi when combined with inorganic fertilizers (Ravikumar and Krishnamoorthy, 1983). Lowest cumulative storage losses were recorded by treatment T_9. In view of these findings, it may be concluded that for higher productivity, garlic should be fertilized with 75:40:40:40 kg NPKS ha^{-1} along with combination of two or three organic manures (FYM, Poultry manure and Vermicompost) equivalent to 15t FYM ha^{-1}. Application of vermicompost and poultry manure improves quality of garlic.

ACKNOWLEDGEMENT

The authors gratefully acknowledge to the Directorate of Onion and Garlic, Rajgurunagar, Pune, Maharashtra, India to carry out this research work through All India Network Research Project on Onion and Garlic.

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