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Impact assessment of integrated nutrient managementon growth, yield and economics of Garlic (*Allium sativum* L.) Cv. G-282 through Front Line Demonstration

Nishith Gupta, K.S. Bhargav, Savita Kumari and A.K. Dixit

R.V.S.K.V.V. Krishi Vigyan Kendra, Dewas 455 001, (M.P.), India

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ABSTRACT

A field trial on Integrated Nutrient Management (INM) in garlic were conducted with farmers participation in Dewas district of Madhya Pradesh for four consecutive years from 2015-16 to 2018-19 to assess the impact of INM on the performance of garlic crop. Demonstration on INM were conducted by applying FYM (15 t/ha) + NPKS (75:40:40:40Kg/ha) + Zinc (5 Kg/ha) + *Azospirillum* and PSB each @ 5 Kg/ha. The study revealed that application of recommended dose of inorganic fertilizers, organic and bio-fertilizers enhanced the growth, yield and yield attributing characters as well as economic performance of garlic. The plant height, number of leaves per plant, neck thickness, bulb diameter and bulb weight was found highest in demonstration plots as compared to farmers practice. The average bulb yield recorded in demonstration plots was 106.74 q/ha which was 16.86% more than farmers practice (91.94 q/ha). An average of Rs. 1,30,618 per hectare net profit was recorded under demonstration plots while it was Rs. 1,04,977 per hectare under farmers practice. The benefit cost ratio was highest in demonstrations (2.74) as compared to farmer's practice (2.44).

Key words : *Impact assessment, Integrated nutrient management, Garlic, Azospirillum, Azotobacter, Technology gap, Extension gap*

Introduction

Garlic (*Allium sativum* L.) commonly termed as "*Lahsun*", is one of the most important spices as well as bulb crop grown throughout in India because it's higher nutritive value as compared to other bulbous crops. It is a versatile horticultural commodity consumed for culinary, medicinal and antimicrobial purposes. The aroma in garlic is due to presence of volatile organo-sulfur compound known as *allicin*. India is second largest garlic producer in the world. The total production of garlic is 12.91 lakh tonnes from the area of 2.44 lakh hectares in the country during 2015. However, the productivity of garlic is 5.29 tonnes/ha in the country which is quite low. Garlic cultivation has assured interest among the farmers of Madhya Pradesh and other parts of the country because of its steadily increasing demand in the market at an attractive rate. In Madhya Pradesh, it occupies an area of 60 thousand hectares with total production of 270 thousand tonnes. The productivity of garlic in Madhya Pradesh is 4.50 t/ha which is far less than that of other states like Punjab (12.16 t/ha), West Bengal (11.94 t/ha), Maharastra (11.43 t/ha) etc. This may be due to its unscientific cultivation particularly nutrient management.

Lack of manuring and balanced fertilization is one of the important causes of low yield of onion. Chemical fertilizers play a major role in increasing garlic bulb yield. However, the fertilizer application in India is mainly restricted to nitrogen, phosphorus and potassium nutrients, which is the root cause for low yields and declining soil fertility status of the soil. It also causeddecline in organic carbon in the soil (Singh *et al.,* 2001). Also, use of only inorganic fertilizers is detrimental to human healthand the environment. Garlic is more susceptible to nutritional deficiency then most other crops as the root system of the crop is shallow and unbranched, so often it respond well to the application of additional fertilizers as reported by Brewster (1994).

Integrated Nutrient Management (INM) practices by the integration of all possible sources of organic, inorganic and bio-fertilizers are required to harness good yield of a crop without causing detrimental effects on soil. It enhances the availability of applied as well as native soil nutrients and minimizes the antagonistic effects resulting from hidden deficiencies and nutrient imbalance. Application of organic manurenot only improves soil organic carbon content but also supplies secondary and micro nutrients required by the crop. Zeidan (2007) also reported that organic manure also improves soil structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity. 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. Keeping the above points in view, field trials were conducted in the farmer's field of Dewas district of Madhya Pradesh to access the effect of INM with bio-fertilizers on growth, yield, yield attributing characters and economics of garlic.

Materials and Methods

The present study was carried out by the Krishi Vigyan Kendra, Dewas during rabi season of 2015-16, 2016-17, 2017-18and 2018-19 in the farmers field located in the operational area of KVK. Each demonstration was laid out in an area of 0.1 hectare and adjacent to the demonstration plot, a check plot (farmers practice) of same area was maintained for the comparison. The selected beneficiaries were provided with all the essential inputs like urea, single super phosphate, muriate of potash, zinc sulphate, gypsum, azospirillum and phosphorus solubilizing bacteria. The soil of the study area was generally light to medium black in texture with low organic carbon, low to medium nitrogen, low to medium phosphorus and high in available potassium.

INM module recommended by Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Pune *viz.* FYM (15t/ha) + NPKS @ 75:40:40:40 Kg/ha + Azospirillum and PSB each @ 5 Kg/ha was applied in the demonstration plots. The full quantity of FYM, phosphorus, potash, sulphur, zinc, azospirillum and PSB and one third of nitrogen were applied as basal dose and remaining two third of nitrogen were applied in two equal splits at 30 and 45 days after planting. Recommended biofertilizers were mixed with FYM having 50% moisture, stored overnight and applied before planting.

Cloves of garlic variety G-282 (Yamuna Safed-3) were treated with mancozeb @ 3 g/kg seed and sown during the month of October every year at a spacing of 15 cm x 10 cm. Different growth and yield parameters such as plant height (cm), number of leaves, length of leaves (cm), neck thickness (cm), equatorial and polar bulb diameter (cm), number of cloves/bulb, clove length (cm), clove weight (g), average bulb weight (g) and bulb yield (q/ha) were recorded. The data on production cost and monetary returns were collected from both the demonstrations and check plots to work out the economic feasibility of the trials. Cost of cultivation was calculated on the basis of prevailing rate of inputs. Gross income was calculated by yield multiplied with whole sale rate of onion. Net income and benefit cost ratio was computed by the following formula.

Net income = Gross income – Total cost of cultivation

$$\text{Benefit cost ratio} = \frac{\text{Gross income}}{\text{Cost of cultivation}}$$

The technology gaps, extension gaps and technology index were calculated as per following formula given by Samui *et al*. (2000).

Technology Gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Farmers yield (Local check)

$$\text{Technology Index} = \frac{(Yi^* - Yi)}{Yi^*} \times 100$$

Where, Yi^* = Potential yield of i^{th} crop

Yi = Demonstration yield of i^{th} crop

Results and Discussion

Growth parameters

Perusal of the data (Table 1) exhibited that combined application of NPK fertilizers, micro nutrients, organic manures and bio-fertilizers were found positive effect on growth characters of garlic as compared to local check plots during all the years. The maximum plant height (58.47cm), number of leaves (8.86), length of leaves (41.62 cm) and neck thickness (0.82 cm) was recorded under demonstration plots (Recommended Practice) as compared to local check plots (Farmers Practice) in which the farmers were applied imbalance dose of fertilizer without application of organic manure and bio-fertilizer. 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 farm yard manures will be released slowly. Hence, combination of these inorganic fertilizer and FYM 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. Gowda *et al.,* (2007) studied the influence of integrated nutrient management in garlic cv. G-282 and observed that 100 % NPK + Biofertilizer + Vermicompost recorded significantly higher bulb yield, plant height, number of leaves and girth of plant.

Yield and yield attributing parameters

All the important attributes related to bulb characteristics were significantly influenced by the integrated nutrient management practices (Table 2). Different yield attributing parameters like equatorial diameter (4.14 cm), polar diameter (3.99 cm), number of cloves/bulb (26.83), clove length (3.24), clove weight (1.84) and average bulb weight (25.71 g) was recorded highest in demonstration plots as compared to farmers practice. This might be due to gradual and steadyrelease of nutrient during the growth period as well asenhanced biological activity and proper nutrition to the crop (Nainwal *et al.,* 2015). Moreover, FYM contains a goodrange of some very essential micronutrient other than NPK fertilizers required for healthy plant growth.

Bulb yield of garlic was found substantially higher in demonstration plots than local check plots during all the years. Under different locations, average bulb yield of garlic in demonstration plot was 106.70 q/ha, whereas, under local check plots (farm-

Table 1. Effect of INM on growth attributes of garlic var. G-282.

Year	Plant Height (cm)		No. of leaves		Length of leaves (cm)		Neck thickness (cm)	
	RP	FP	RP	FP	RP	FP	RP	FP
2015-16	59.03	55.18	8.60	7.34	41.52	37.12	0.79	0.64
2016-17	58.11	53.26	8.92	8.06	41.98	38.40	0.86	0.68
2017-18	59.74	56.32	9.11	8.14	42.12	38.69	0.81	0.70
2018-19	56.99	51.82	8.79	8.07	40.85	37.63	0.82	0.59
Mean	58.47	54.15	8.86	7.90	41.62	37.96	0.82	0.65

Table 2. Effect of INM on yield attributing attributes of garlic var. G-282.

Year	Equatorial Diameter of bulb (cm)		Polar Diameter of bulb (cm)		No. of cloves/ bulb		Clove length (cm)		Clove weight (g)		Av. bulb weight (g)		Bulb yield (q/ha)		Increase in yield (%)
	RP	FP	RP	FP	RP	FP	RP	FP	RP	FP	RP	FP	RP	FP	
2015-16	4.12	3.94	3.97	3.81	24.13	21.64	3.18	3.04	1.69	1.58	22.54	19.73	101.20	85.45	18.43
2016-17	4.03	3.79	3.81	3.56	25.44	20.17	3.12	2.89	1.82	1.61	25.36	21.81	105.13	92.08	14.17
2017-18	4.18	3.26	4.02	3.21	29.62	24.22	3.26	2.92	1.87	1.69	26.13	22.18	107.63	92.33	16.57
2018-19	4.22	3.92	4.16	3.80	28.12	22.67	3.41	3.06	1.96	1.88	28.82	24.69	112.85	97.88	15.29
Mean	4.14	3.73	3.99	3.60	26.83	22.18	3.24	2.98	1.84	1.69	25.71	22.10	106.70	91.94	16.12

ers practice), it was found to be 91.94 q/ha which was 16.12% higher than the control plots. This result was in line with the findings of Solanki *et al.,* (2014) and Tarai *et al.,* (2015). The year wise fluctuation in yield was observed mainly due to the soil moisture availability, climatic aberrations, disease and pest attack as well as the change in the location of trials every year. However, the variation of yield from location to location can be accounted for varying climatic conditions, prevailing micro climate and variation in agricultural practices followed.

Technology and Extension gap

The average technology and extension gap of four year trial was 63.30 q/ha and 14.77 q/ha respectively. Though the demonstration trials were laid out under the supervision of multi disciplinary team of scientist in farmer's field, there exists a gap between the potential yield and the demonstration yield. The technology gap observed may be due to dissimilarity in soil fertility status, marginal land holdings, managerial skills of individual farmers and the climatic condition of the area. Hence, variety wise location specific recommendations appear to be necessary to minimize the technology gap for yield level in different situations (Ojha and Singh, 2013).

Extension gap emphasized the need to educate the farmers about INM practices through various extension means like FLD, OFT and training to revert the trend of wide extension gap. This high extension gap requires urgent attention from planners, scientists, extension personal and development departments. Similar results were also obtained by Gupta *et al.* (2015) in kharif onion.

Technology index

The adoption of technology in demonstration trials were studied through technology index. Technology index shows the feasibility of the demonstrated technology at the farmer's field. The lower the value of the technology index more is the feasibility of the technology (Jeengar *et al.,* 2006). Table 3 revealed that the technology index varied from 33.62 to 40.47 percent. On an average, technology index was observed 37.24% which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technical intervention to increase the yield performance of onion and lower down the losses meant by deficiency of nutrients in crop.

Economic Return

The economic analysis of the data for the study period clearly revealed that the gross return, net return and benefit cost ratio were highest in front line demonstration where recommended practices were followed as compared to farmers practice.

Economic indicators depicted in Table 4 showed that the total cost of cultivation in demonstration

Table 3. Technology gap, extension gap and technology index of garlic.

Year	Potential Yield (q/ha)	Technology gap (q/ha)	Extension gap (q/ha)	Technology Index (%)
2015-16	170	68.80	15.75	40.47
2016-17	170	64.87	13.05	38.16
2017-18	170	62.37	15.30	36.69
2018-19	170	57.15	14.97	33.62
Mean	170	63.30	14.77	37.24

Table 4. Economic impact of IPNM module in the farmer's field.

Year	Cost of Cultivation (Rs/ha)		Gross Return (Rs/ha)		Additional Gross Return (Rs/ha)	Net Return (Rs/ha)		Additional Net Return (Rs/ha)	B:C Ratio	
	RP	FP	RP	FP		RP	FP		RP	FP
2015-16	73324	70022	151800	128175	23625	78476	58153	20323	2.07	1.83
2016-17	74734	72423	168208	147328	20880	93474	74905	18569	2.25	2.03
2017-18	75346	72687	236786	203126	33660	161440	130439	31001	3.14	2.79
2018-19	76117	73606	265198	230018	35180	189081	156412	32669	3.48	3.12
Mean	74880	72185	205498	177162	28336	130618	104977	25641	2.74	2.44

plots ranged from Rs. 73,324 to Rs. 76,117 per hectare, while the cost under local check was ranged from Rs. 70,022 to Rs. 73,606 per hectare. However, the average cost of cultivation was Rs. 74,880 and Rs. 72,185 per hectare in demonstration and local check plots respectively. IPNM module gave additional gross and net return of Rs. 28,336 and Rs. 25,641 respectively during all the years. The average benefit cost ratio of four years was 2.74 and 2.44 in demonstration and local check plots respectively. This may be due to higher yield obtained under improved technologies as compared to local check (farmers practice).

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