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Research Article

RESPONSE OF INTEGRATED PLANT NUTRIENT MANAGEMENT ON GROWTH, YIELD AND ECONOMICS OF ONION UNDER FARMERS FIELD CONDITIONS

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Abstract- The present investigation was conducted by Krishi Vigyan Kendra, Dewas for five consecutive years from 2011-12 to 2015-16 to find out the effect of Integrated Plant Nutrient Management (IPNM) on the performance of the onion crop during *rabi* season. Demonstration on IPNM were conducted by applying FYM (10 t/ha) + NPKS (130:50:50:20 Kg/ha) + Zinc (5 Kg/ha) + Azospirillum and PSB each @ 5 Kg/ha followed by dipping of seedling roots in 1% Azotobacter solution. The results showed that the growth, yield and yield attributing characters perform well under IPNM plots. 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 IPNM practices was 303.89 q/ha which was more than local check plots (272.34 q/ha). The increment in yield over local check was 13.64 percent. The technology gap, extension gap and technology index was 21.11 q/ha, 31.55 q/ha and 9.54 percent respectively. An average of Rs.194805 per hectare net profit was recorded under demonstration plots while it was Rs. 169037 per hectare under farmers practice. The benefit cost ratio was highest in demonstrations (4.57) as compared to farmer's practice (4.22).

Keywords- Integrated Plant Nutrient Management, Onion, Azospirillum, Azotobacter, Technology Gap, Extension Gap.

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Introduction

Onion (*Allium cepa* L.) is an important bulb crop of India, which is extensively cultivated throughout India for its high nutritional and medicinal properties. It is a maligned vegetable and is widely used as salad, cooked in curries, boiled, fried, baked and picked. Onion is called as "Queen of Kitchen" [1]. Onion is stimulant, diuretic and having expectorant and antibacterial properties. It prevents heart disease by lowering blood cholesterol and lipid level [2]. India is the second largest producer of onion in the world with an area of 1203.60 thousand hectares and production of 19401.7 thousand MT next only to China [3]. Its productivity was low i.e. 16.1MT/ha as compared to world average productivity (19.3 MT/ha). Maharashtra is the largest producer (5864 thousand MT) of onion in the country, but per hectare productivity is highest in Gujarat (25.4 MT/ha) followed by Madhya Pradesh (24.1 MT/ha).

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 onion bulb yield. However, the fertilizer application in India is mainly restricted to nitrogen, phosphorus and potassium nutrients. Further, the application is unbalanced, titled more towards N followed by P and K, which is the root cause for low yields and the declining soil fertility status of the soil. Also use of only chemical fertilizers are detrimental to human health and the environment [4]. Introduction of fertilizer responsive, high yielding varieties, extension of irrigated area, high use of chemical fertilizers and pesticides have resulted in relatively declined contribution of organic manures as a source of plant nutrition. However, with the increase in the cost of inputs, the inorganic fertilizers become more expensive [5]. Onion is more susceptible to nutritional deficiency than most other crops as the root system of the crop is shallow and un-branched, so often it responds well to the application of additional fertilizers [6].

Integrated Plant Nutrient Management (IPNM) 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 manure not only improves soil organic carbon content, but also supplies secondary and micro nutrients required by the crop. Organic manure also improves soil structure and water holding capacity, resulting in more extensive root development and enhanced soil micro flora and fauna activity [7]. Some workers [8] reported that the yield of onion is increased with the application of organic manure. Bio-fertilizer is one of the most important components of IPNM, as they are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture. Among different bio-fertilizers, azospirillum and phosphorus solubilizing bacteria (PSB) contribute significant improvement in the yield of vegetable crops by 15-20% [9]. In addition to these, bio-fertilizers inoculations of onion increased the yield and saved the fertilizer requirement by 25%, thereby reducing the cost of cultivation [10].

Through the cultivation of rabi onion occupies a prominent position in the state as well as in the district, but a vast yield gap exists between potential yield and yield under real farming situation. The available agricultural technology does not serve the very purpose until it reaches and adopted by its ultimate users the farmers. Yet adoption levels for several components of the improved technology were low, emphasizing the need for better dissemination. Conducting of demonstration of Integrated Plant Nutrient Management (IPNM) in the farmer's field helps in identifying the constraints and potential of the onion production in specific areas as well as it helps in improving the economic and social status of the farmers. 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 IPNM with bio-fertilizers on growth, yield and yield attributing characters of onion.

Materials and Methods

The present study was carried out by the Krishi Vigyan Kendra, Dewas during rabi season of 2011-12, 2012-13, 2013-14, 2014-15 and 2015-16 in then the farmers field of adopted villages located in the operational area of KVK. Each demonstration was conducted in an area of 0.1 hectares and adjacent to the demonstration plot, a check plot (farmers practice) of the same area was maintained for the comparison. The demonstrations were conducted in different villages (Arnia, Ajnas, Jamgod, Kankarda, Nanadharakhedi, Narana, Bhoransa) of the district in 50 farmers field in 5.5 hectare land for a period of five consecutive years. Each year prior to the implementation of the programme all selected farmers were trained on integrated plant nutrient management in onion. These selected beneficiaries were provided with all the essential inputs like seed, urea, single super phosphate, muriate of potash, zinc sulphate, gypsum, azospirillum, phosphorus solubilizing bacteria (PSB) and azotobacter. 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.

IPNM module recommended by Directorate of Onion and Garlic Research (DOGR), Rajgurunagar, Pune *viz.* FYM (15t/ha) + NPKS @ 110:40:60:20 Kg/ha + Azospirillum and PSB each @ 5 Kg/ha was modified on the basis of soil testing report and availability of organic matter. Finally, module on IPNM was designed with the active participation of selected farmers as FYM 10 t/ha + NPKS @ 130:50:50:20 Kg/ha + 5 Kg/ha zinc and azospirillum and PSB each @ 5 Kg/ha followed by a root dip of seedlings in 1% azotobacter solution and applied in the farmer's field. The full quantity of FYM, phosphorus, potash, sulphur, zinc, azospirillum and PSB and half dose of nitrogen were applied as basal dose and remaining half nitrogen was applied in two equal splits at an interval of 30 and 45 days after transplanting.

Seeds of onion variety Agrifound light red were treated with carbendazim @ 3 g/kg seed and sown in line during the month of October every year. 60 days after sowing, the seedlings were ready for transplanting. Before transplanting, the seedlings were dipped in a 1 % solution of azotobacter and transplanted in the field at a spacing of 15 cm x 10 cm. Frequent training programs and field visits were conducted in a farmer's field by the KVK scientists during the various field operations like transplanting, broadcasting of urea, irrigation, spraying of insecticide and herbicide and harvesting etc. All other steps like the site and farmer selection, layout of demonstration, farmers participation etc were followed as suggested by [11]. Visits of the farmers and the extension functionaries were organized at demonstration plots to disseminate the message at large. Different growth and yield parameters such as plant height (cm), number of leaves per plant, neck thickness (cm), bulb diameter (cm), average bulb weight (g) and bulb yield (q/ha) were recorded. Data on the 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 a wholesale rate of onion. The benefit cost ratio was computed by the following formula.

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

The technology gaps, extension gaps and technology index were calculated as per following formula given by [12].

Technology Gap = Potential yield – Demonstration yield

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

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

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

Yi = Demonstration yield of i^{th} crop

Results and Discussion

Growth and yield attributing parameters

Perusal of the data exhibited that a combined application of NPK fertilizers, micronutrients, organic manures and bio-fertilizers were found positive effect on growth and yield attributing parameters of onion as compared to local check plots during all the years [Table-1]. The maximum plant height (39.49 cm), number of leaves per plant (10.70), neck thickness (0.95 cm), bulb diameter (5.16 cm), and average bulb weight (70 g) was recorded under IPNM plots as compared to local check plots in which the farmers were applied imbalance dose of fertilizer without application of organic manure and bio-fertilizer. Enhanced plant growth might be due to higher nutrient availability as well as better nutrient uptake by the crop [13]. Higher absorption of nutrients, especially nitrogen enhanced cell division and cell elongation resulted in increase metabolic activities. This might be the other reason for obtaining higher plant growth in the demonstration plots. The added organic manure in terms of farmyard manure would have improved the soil physical conditions and increase nutrient availability resulting in better plant growth. These results are in conformity with the findings of [14]. Microorganism work efficiently in dissolving nutrients and making them available to plant if amended with organic fertilizers [15, 16].

Table-1 *Growth and yield attributing characters of onion as influenced by IPNM*

Year	Plant Height (cm)		No. of leaves per plant		Neck Thickness (cm)		Bulb diameter (cm)		Bulb Weight (g)	
	IPNM Plot	Check Plot	IPNM Plot	Check Plot	IPNM Plot	Check Plot	IPNM Plot	Check Plot	IPNM Plot	Check Plot
2011-12	39.86	35.21	10.13	7.61	0.89	0.72	4.97	4.20	67	61
2012-13	37.09	34.68	9.86	6.37	0.96	0.81	5.21	4.71	66	58
2013-14	41.63	37.11	10.72	7.24	1.01	0.92	5.16	4.57	70	62
2014-15	40.24	36.88	11.06	8.33	0.91	0.76	5.38	4.77	73	62
2015-16	38.62	33.82	11.73	8.16	0.99	0.87	5.09	4.41	76	69
Mean	39.49	35.54	10.70	7.54	0.95	0.82	5.16	4.53	70	62

Yield

The data presented in [Table-2] revealed that under demonstration plots, onion bulb yield was found substantially higher than local check plots during all the years. Under different locations, average bulb yield of onion in demonstration was 303.89 q/ha, whereas, under local check plots (farmers practice), it was found to be 272.34 q/ha. The productivity of the onion crop ranged from 289.58 q/ha to 319.52 q/ha which was 13.64% higher than the control plots. This result was in line with the findings of [17-19]. The year wise fluctuation in yields 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 might be due to variation in soil and climatic conditions, prevailing micro climate and variation in agricultural practices followed. More or less similar reasoning was given by other workers like [20-22].

Technology gap

The technology gap, the difference between potential yield and demonstration yield were 35.42, 30.82, 20.99, 12.83 and 5.48 q/ha during 2011-12, 2012-13, 2013-14, 2014-15 and 2015-16 respectively. The average technology gap of five year trial was 21.11 q/ha. Though the demonstration trials were laid out under the supervision of a multidisciplinary team of scientist in a 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 as reported by [23].

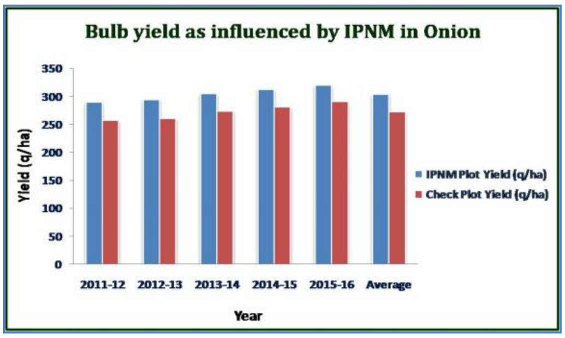

Fig-1 Bulb yield of onion influenced by IPNM

Extension gap

Extension gap, which is the difference between demonstration yield and farmers practice yield was 32.37, 33.96, 31.10, 30.97 and 29.37 q/ha during 2011-12, 2012-13, 2013-14, 2014-15 and 2015-16 respectively. However, the average extension gap was observed 31.55 q/ha which emphasized the need to educate the farmers about IPNM practices through various extension means like FLD, OFT and training to revert the trend of the wide extension gap. This high extension gap requires urgent attention from planners, scientists, extension personal and development departments. [24] also opined that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity. Similar results were also obtained by [25] in *khariff* onion.

Technology index

The adoption of technology in demonstration trials were studied through a technology index. The 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 [26]. [Table-2] revealed that the technology index varied from 3.95 to 16.86 percent. On an average, technology index was observed 9.54%, which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technical interventions to increase the yield performance of onion and lower down the losses due to deficiency of nutrients in the crop.

Table-2 *Yield, technology gap, extension gap and technology index of onion*

Year	Bulb Yield (q/ha)		Increase in yield (%)	Technology Gap (q/ha)	Extension Gap (q/ha)	Technology Index (%)
	IPNM Plot	Check Plot				
2011-12	289.58	257.21	17.14	35.42	32.37	10.90
2012-13	294.18	260.22	15.27	30.82	33.96	9.48
2013-14	304.01	272.91	13.47	20.99	31.10	6.49
2014-15	312.17	281.20	12.21	12.83	30.97	3.95
2015-16	319.52	290.15	10.12	5.48	29.37	16.86
Mean	303.89	272.34	13.64	21.11	31.55	9.54

Economic Return

The input and output prices of commodities prevailed during each year of demonstration were taken for calculating the cost of cultivation, gross return, net return and benefit cost ratio. The economic analysis of the data for the study period clearly revealed that the gross return, additional net return and benefit cost ratio were higher in front line demonstrations where recommended practices were followed as compared to farmers practice indicating higher profitability.

Table-3 *Economic impact of IPNM module in the farmer's field*

Year	Cost of cultivation (Rs/ha)		Gross Return (Rs/ha)		Additional gross return in IPNM Plot (Rs/ha)	Net Return (Rs/ha)		Additional net return in IPNM Plot (Rs/ha)	B : C Ratio	
	IPNM Plot	Check Plot	IPNM Plot	Check Plot		IPNM Plot	Check Plot		IPNM Plot	Check Plot
2011-12	51147	48902	130311	115745	14566	79164	66843	12321	2.55	2.37
2012-13	52242	50301	213281	188660	24621	161039	138359	22680	4.08	3.75
2013-14	53090	51451	357212	320669	36543	314122	269218	44904	6.73	6.23
2014-15	53676	52752	343387	309320	34067	289711	256568	33143	6.40	5.86
2015-16	61724	59891	191712	174090	17622	129988	114199	15789	3.11	2.91
Mean	54376	52659	247181	221697	25484	194805	169037	25767	4.57	4.22

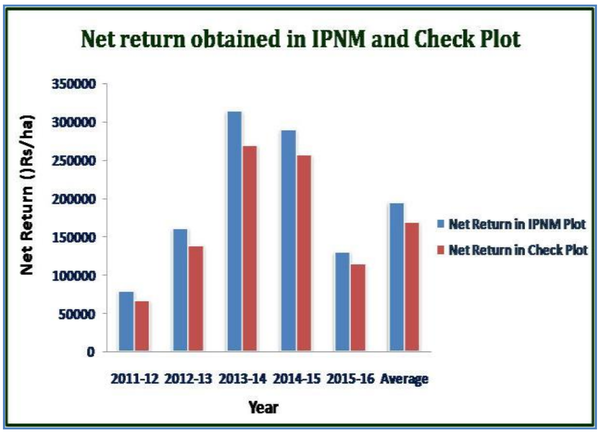

Fig-2 Net return obtained in demonstration and farmer's practice

Economic indicators depicted in [Table-3] showed that the total cost of cultivation in demonstration plots ranged from Rs. 51147 to Rs. 61724 per hectare, while the cost under local check was ranged from Rs. 48902 to Rs. 59891 per hectare. However, the average cost of cultivation was Rs. 54376 and Rs. 52659 per hectare in demonstration and local check plots respectively. IPNM module under demonstration plots gave an additional net return of Rs. 12321, 22680, 44904, 33143 and 15789 per hectare during 2011-12, 2012-13, 2013-14, 2014-15 and 2015-16 respectively with the average of Rs. 25767 per hectare as compared to farmers practice. The benefit cost ratio under demonstration plots was 2.55, 4.08, 6.73, 6.40 and 3.11 as compared to 2.37, 3.75, 6.23, 5.86, and 2.91 under farmers practice during 2011-12, 2012-13, 2013-14, 2014-15 and 2015-16 respectively. However, the average benefit cost ratio of five years was 4.57 and 4.22 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).

Conclusion

The IPNM module assessed during the study period proved as an effective tool in changing attitude, skill and knowledge on IPNM in Eco friendly onion production, which gives better yield due to proper utilization of plant nutrients, improved soil health and minimize disease incidences. Based on farmer's feedback, it was observed that the use of IPNM module in onion was highly acceptable, easily compatible in existing production and cropping systems. The productivity gain under the IPNM module over conventional practices created greater awareness and motivated other farmers to adopt appropriate technologies of onion. The economic feasibility of the present study revealed that the highest return per rupee invested was obtained under integrated use of organic manure, inorganic fertilizer and bio-fertilizer. So it was concluded that by conducting demonstrations of IPNM yield potential of onion could be enhanced to a greater extent with an increase in the income level of farming community.

Conflict of Interest: None declared

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