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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(6): 172-181

www.thepharmajournal.com
Received: 09-04-2020
Accepted: 11-05-2020

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"Studies on effect of integrated nutrient management and bio enhancer on productivity of Onion (*Allium cepa* L)"

Usha Patel

Abstract
The experiment was conducted during 2015-2016 with 14 treatment combination of inorganic, organic and biological sources of nutrient in garlic. The experiment was laid out in randomized block design (RBD) in three replications with fourteen treatments viz. T1 -RDF (100:80:80 kg/ha), T2-50% RDF+ FYM @15 t/ha, T3-50% RDF + VC@5t /ha, T4-25% RDF+ FYM @20 t/ha, T5-25% RDF + VC@7.5t/ha, T6- FYM @ 30 t/ha, T7-Varmi compost @ 10 t/ha, T8-FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T9-Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T10-FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T11-Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T12- Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya, T13-Varmi compost @ 2.5 t/ha + Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya + Varmi wash, T_{14}- Farmer practice NPK 80:60:60 kg/ha. The experiment findings based on observations viz. plant height, number of leaves/plant, leaf length, leaf width, collar length, collar thickness, polar diameter, equatorial diameter, average bulb weight, neck thickness, total soluble solids, different grades of bulbs, marketable bulb yield and total bulb yield.

Keywords: Onion, Nutrient management, Bio enhancer and Yield

1. Introduction
Onion (*Allium cepa* L.) family Alliaceae is one of the important commercial bulbous crops cultivated extensively in India and widely used as vegetables in our country. Onions are cultivated and used around the world. India is the second largest producer of onion in the world and occupies 756200 hectare area with a production of 12158800.00 t and productivity is 16.10 t/ha. Maharashtra is leading state in area and production whereas, productivity is highest in Gujarat. Madhya Pradesh is second largest producer of Onion occupied 1117000 ha area with total 2691000 production and 24.08t/ ha productivity in year 2010-11. As a foodstuff they are usually served cooked, as a vegetable or part of a prepared savoury dish, but can also be eaten as raw or used to make pickles or chutneys. Consumption is believed to benefit health in that onions contain phenolics and flavonoids that have potential anti-inflammatory, anti-cholesterol, anticancer and antioxidant properties. Agricultural soil has been adversely affected by chemical fertilizers, pesticides, and heavy machinery resulted by organic carbon and microbial pool, which create a unique environment for biologically active soil which has sprinkled since green revolution and it has been observed that most of the soil are not responding towards productivity. Under such circumstances build up of soil health is urgent need. To minimize the cost of cultivation which is beyond the farmer's reach, low cost organic inputs respondent to soil health and crop productivity must be advocated. Inspite of the intensive use of inputs for about half a century in Indian agriculture, the yield gap in various crops still remains large even after following the best practices. Due to the prohibitive cost of chemical fertilizers, majority of Indian farmers who are mostly marginal and small, do not apply the recommended dose of fertilizers. The combined application of organics such as FYM, compost, green leaf manure, vermicompost *etc*. and liquid organics *viz.*, Jeevamrut, Beejamrut, Panchagavya, Gomutra, Angara, Vermiwash *etc.*, which contain microbial count and plant growth promoting substances (PGPR) stimulate growth, yield and quality of crops. Further it helps to build soil organic matter status besides minimizing the cost of cultivation. Panchagavya a promising natural liquid manure is being used by many organic farmers in many crops in different parts of our country (Anon, 2005) [1].

The yield of onion in Chitrakoot is low as compared to other onion producing region of state. One of the reasons for low yield is use of inadequate and unbalanced fertilization, so concept of Integrated Nutrient management and bio enhancer required to be adjusted along with sustainable production.

2. Material and methods

The present investigation entitled "Studies on Effect of integrated nutrient management and bio enhancer on productivity of Onion (*Allium cepa* L.)" was carried out during the year 2015-16 in *Rabi* season at present investigation was carried out at the Agricultural Farm Razaula, M.G.C.V.V Chitrakoot (M.P).

Techniques of analysis

a. Soil sampling

The soil samples were taken from different places of the experimental field with the help of auger from 12–15 cm depth after clearing the surface of vegetation. These samples were properly mixed, air dried in diffused sunlight, finally powdered and again mixed thoroughly. A representative sample of 5 g was taken for each analysis and subjected to mechanical and chemical analysis.

b. Mechanical analysis of soil

The mechanical analysis of sample soil was done with the help of Bouyoucos Hydrometer method and results so obtained are presented in Table 3.1.

Table 3.1: Mechanical composition of soil

Soil Properties	Percentage	Method employed
Sand	56%	Bouyoucos Hydrometer method Bouyoucos (1952)
Silt	23%	
Clay	21%	
Textural Class	Sandy Loam	

c. Chemical analysis of soil

The chemical analysis of soil was conducted to determine the percentage of major elements viz., nitrogen, phosphorus, potash, organic carbon, organic matter, pH and electrical conductivity. Nitrogen was estimated by Alkaline Permanganate method. The phosphorus was estimated by Olsen's Colorimetric method Olsen *et al.*, 1954 and potash was estimated by Flame Photometric method (Jackson, 1958), respectively. The soil organic matter was estimated by Hydrochloric oxidation method as suggested by Walkley and Black 1934. The pH of soil was determined by pH Meter (Elico pH meter model 2.112). The results obtained are presented in Table 3.2.

Table 3.2: Chemical composition of soil

Ingredients	Quantity	Method
Soil pH	7.70	Digital pH Meter Mk. IV
Organic carbon (%)	0.41	Walkley and Black (1934) method
EC (dSm^{-1})	0.28	EC Meter
Available nitrogen (kg ha^{-1})	214.28	Alkaline Permanganate method (Subbiah and Asija, 1956)
Available phosphorus (kg ha^{-1})	23.72	Olsen's Colorimetric method (Olsen *et al.*, 1954)
Available potassium (kg ha^{-1})	223.34	Flame photometric method (Jackson, 1958)

Table 3.3: Details of the experiment

Crop	Onion (*Allium cepa* L.)
Variety	Agrifound Light Red
Design	Randomized Block Design
Number of Treatments	14
Number of Replications	3

Treatment details

Treatment no	Treatment
T1	RDF (100:80:80 kg/ha)
T2	50% RDF+ FYM @15 t/ha
T3	50% RDF + VC@5t/ha
T4	25% RDF+ FYM @20 t/ha
T5	25% RDF + VC@7.5t/ha
T6	FYM @ 30 t/ha
T7	Varmi compost @ 10 t/ha
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya + Varmi wash
T14	Farmer practice NPK 80:60:60 kg/ha

3. Statistical analysis

Analysis of variance

The data based on the mean of individual plants selected for observation were statistically analyzed described by Panse and Sukhatme 1967 [28] to find out overall total variability present in the material under study for each character and for all the populations. The first and foremost step is to carry out analysis of variance to test the significance of differences among the populations. The skeleton of analysis of variance used was as follows:

Table 3.4: ANOVA for Randomized Completely Block Design

Source of variation	D.F	Sum of square	Mean sum of square	F value	F_t 5% or 1% table value
Replication	r-1	RSS	RMS	RMS/EMS	-
Treatment	t-1	TrSS	TrMS	TrMS/EMS	-
Error	(r-1)(t-1)	ESS	EMS	-	-
Total	rt-1	TSS	-	-	-

Where,

r = Number of replications
t = Number of treatments
D.F = Degree of freedom
RSS = Replication sum of square
TrSS = Treatment sum of square
ESS = Error sum of square
TSS = Total sum of square
RMS = Replication mean sum of square
TrMS = Treatment mean sum of square
EMS = Error mean sum of square

$$C.V. = \frac{\sqrt{EMS}}{GM} x100$$

A significant value of F test indicates that the test entries differ significantly among themselves, which requires computing.

$$C.V. = \frac{\sqrt{EMS}}{GM} x100$$

$$SE\ m \pm = \sqrt{\frac{EMS}{r}}$$

CD at 5% prob. Level = SE diff x $t_{5\%}$ table value

Where,

C.V = Coefficient of variation
SEm± = Standard error of means
S E diff = Standard error of difference
GM = Grand mean
C.D = Critical difference
t 5% = t, table value 5% probability level at error d.f.

4. Results and discussion

The results of the present investigation entitled "Studies on Effect of integrated nutrient management and bio enhancer on productivity of Onion (*Allium cepa* L.)" was carried out during the year 2015-16 in Rabi season are presented in this chapter with the help of tables, figures, illustrations, graphical representation and discussed properly.

During the course of investigation, data were recorded on various growth, yield and quality parameters in respect to application of inorganic, organic and bio-fertilizer on onion.

Growth characters

The growth contributing characters were recorded for the following variables namely plant height, number of leaves/ plant, collar height, collar thickness, leaf length and leaf width.

Yield and quality characters

The yield and quality characters were recorded for the following variables namely polar diameter, equatorial diameter, neck thickness, average weight of bulb, grade wise yield, marketable bulb yield and total yield.

Growth characters

Plant height (cm)

The data recorded on height of plant at different growth stages are presented in the Table 4.1 and depicted through Fig 4.1.

The observation of plant height were recorded at 60 and 90 days interval and the result showed significant differences between the treatments other than 30 days.

After 30 days after transplanting the result shows that, the maximum plant height of onion i.e. 41.44 cm was recorded under T1 followed by under T12 (40.87 cm). Which were at par with each other after 30 days after transplanting. The minimum plant height (28.21 cm) was recorded under farmer practice (T14).

Table 4.1: Effect of integrated nutrient management and bio enhancer on plant height (cm) at different interval of onion

Treatment no.	Treatment	30	60	90
T1	RDF (100:80:80 kg/ha)	41.44	45.91	52.28
T2	50% RDF+ FYM @15 t/ha	33.90	37.56	45.15
T3	50% RDF + VC@5t/ha	35.30	39.10	46.72
T4	25% RDF+ FYM @20 t/ha	33.52	37.13	43.26
T5	25% RDF + VC@7.5t/ha	35.31	39.11	44.87
T6	FYM @ 30 t/ha	35.21	34.00	39.07
T7	Varmi compost @ 10 t/ha	33.75	35.39	39.91
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	36.41	40.33	44.29
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	36.81	40.76	45.23
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	37.31	41.31	46.94
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	38.54	42.67	48.71
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	40.87	44.54	50.34
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya + Varmi wash	37.21	44.98	51.68
T14	Farmer practice NPK 80:60:60 kg/ha	28.21	32.61	45.83
	SEm±	NS	1.213	01.09
	CD (P=0.05)	NS	3.604	03.31

At 60 days after transplanting, the maximum plant height (45.91 cm) was recorded under T1 followed by T13 (44.98 cm) and T4 (47.17 cm). The minimum plant height (32.61 cm) was recorded under farmer practice (T14).

In case of 90 days after transplanting, the plant height was maximum in T1 (52.28 cm) which was at par with T13 (51.68

cm). While, minimum plant height was obtained in T14 (45.83 cm).

The plant height was recorded maximum under T1 (100% of recommended dose of fertilizer) with found at par with T1 that give the full opportunity to plant for optimum growth and development might be due to the increase in cell size and enhancement of cell division, which ultimately resulted in increased plant height. Similar finding were also reported by Pall and Padda (1972) [16], Chakrabarti *et al.* (1980) [6], Nehra *et al.* (1988) [14].

Number of leaves/plant

The number of leaves/plant counted at different stages of crop growth showed non-significant differences (Table 4.2 and Fig 4.2).

At 30 days after transplanting, number of leaves/plant ranged from 7.10 to 5.09. On the basis of means, the maximum number of leaves/plant was counted in T1 (7.10) followed by T10 (6.73) and T12 (6.61). The minimum number of leaves/ plant was counted in T14 (5.09).

In case of 60 days after transplanting, the mean value for number of leaves/plant were maximum in T13 (7.86) followed by T_1 (7.80). The minimum number of leaves/plant were counted in T14 (5.67).

Data recorded at 90 days after transplanting found no significant difference but on the basis of mean the maximum number of leaves/plant were counted in T13 (8.85) followed by T_1 (8.73).. Whereas, minimum number of leaves/plant in T14 (7.22).

The 100% RDF and Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya+ Varmi was with organic substance were produced comparatively higher number of leaves as comparison to farmer practice.

Table 4.2: The effect of integrated nutrient management and bio enhancer on number of leaves/plant at different interval of onion

Treatment no	Treatment	30	60	90
T1	RDF (100:80:80 kg/ha)	07.03	7.80	08.73
T2	50% RDF+ FYM @15 t/ha	06.10	07.76	08.40
T3	50% RDF + VC@5t/ha	05.83	07.66	08.40
T4	25% RDF+ FYM @20 t/ha	06.16	07.76	08.46
T5	25% RDF + VC@7.5t/ha	06.23	07.66	08.16
T6	FYM @ 30 t/ha	06.06	07.33	08.83
T7	Varmi compost @ 10 t/ha	05.76	07.80	08.26
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	05.96	07.76	08.36
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	6.33	7.19	7.88
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	6.73	7.24	8.12
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	06.13	07.19	08.61
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	06.61	06.95	08.24
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya+ varmiwas	7.10	7.86	8.85
T14	Farmer practice NPK 80:60:60 kg/ha	5.09	5.67	7.22
	SEm±	00.21	00.57	00.40
	CD (P=0.05)	NS	NS	NS

Similar results have been reported by Reddy *et al.* (2002) in tomato and Yadav *et al.* (2003)

Leaf length (cm)

Table 4.3: Effect of integrated nutrient management and bio enhancer on leaf length (cm) at different interval of onion

Treatment No	Treatment	4th WAT	5th WAT	6th WAT	7th WAT
T1	RDF (100:80:80 kg/ha)	34.45	37.29	38.81	39.27
T2	50% RDF+ FYM @15 t/ha	32.13	33.54	35.12	35.60
T3	50% RDF + VC@5t/ha	32.43	34.17	35.45	36.00
T4	25% RDF+ FYM @20 t/ha	30.58	32.16	33.78	34.80
T5	25% RDF + VC@7.5t/ha	31.19	32.79	33.97	34.92
T6	FYM @ 30 t/ha	22.46	25.57	28.21	30.85
T7	Varmi compost @ 10 t/ha	30.23	31.45	31.99	32.34
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	23.47	26.67	28.82	30.76
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	28.21	29.98	30.90	32.89
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	30.23	31.75	34.12	35.60
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	31.54	33.06	34.39	35.84
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	33.59	35.15	37.26	37.61
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya+ varmiwash	33.81	36.07	38.16	39.00

T14	Farmer practice NPK 80:60:60 kg/ha	22.46	25.57	28.21	30.85
	SEm±	01.16	01.11	01.32	00.85
	CD (P=0.05)	03.52	03.37	04.01	02.58

*WAT = Week after transplanting

After 4th week after transplanting, leaf length of the plant ranged from 22.46 cm to 34.45cm. The maximum leaf length was recorded under T1 (34.45cm), which was statistically at par with T4 (30.58cm), T6 (22.46cm), T7 (30.23cm) T8 (23.47cm) and T9 (28.21cm) while minimum leaf length was recorded in T14 (22.46 cm).

Data recorded at 5th week after transplanting showed that leaf length of different treatments ranged from 25.57 cm to 37.29 cm. The maximum leaf length (37.29 cm) was recorded in T1, which was at par with T13 (36.07 cm), T12 (35.15 cm), T3 (34.17cm), while the minimum leaf length recorded in T14 i.e. 25.57 cm.

The leaf length 6th week after transplanting of ranged from 28.21cm to 38.81cm. The maximum leaf length of the plant was recorded in T1 (38.81cm), which was statistically at par with T13 (38.16 cm) and T12 (37.26cm). Minimum leaf length (28.21 cm) was recorded in T14.

At 7th week after transplanting showed that leaf length of different treatments ranged from 30.85cm to 39.27 cm. The maximum leaf length was recorded in T1 (39.27cm), which was at par with other treatments i.e. T13 (39.00 cm) and T12 (37.61cm). Whereas, minimum leaf length was recorded in T14 (30.85 cm).

In the present study, it was observed that the leaf length was significantly higher when onion was cultivated with recommended dose of NPK , Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya and Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya+ Varmi wash. The higher leaf length might be due to the adequate availability and supply of nutrients in appropriate proportion. Similar results have reported by Sreenivasa (2011) [11].

Leaf width (cm)

The leaf width of the plant at different stages of plant growth is presented in Table 4.4 and shown in Fig 4.4.

After 4th weeks of transplanting, leaf width of the plant ranged from 0.66 cm to 1.02 cm. The maximum leaf width was recorded under T_1 (1.02 cm) followed by T14 (1.00 cm), while minimum leaf width was recorded in T14 (0.66 cm).

Table 4.4: Effect of integrated nutrient management and bio enhancer on leaf width (cm) at different interval of onion

Treatment no	Treatment	4th WAT	5th WAT	6th WAT	7th WAT
T1	RDF (100:80:80 kg/ha)	1.02	1.36	1.59	1.92
T2	50% RDF+ FYM @15 t/ha	0.90	1.28	1.42	1.86
T3	50% RDF + VC@5t/ha	0.93	1.30	1.45	1.89
T4	25% RDF+ FYM @20 t/ha	00.84	00.98	01.36	01.62
T5	25% RDF + VC@7.5t/ha	00.83	01.14	01.43	01.69
T6	FYM @ 30 t/ha	00.68	00.99	01.22	00.62
T7	Varmi compost @ 10 t/ha	00.69	01.07	01.28	00.87
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60, 75 and 90 DAP	00.97	01.16	01.40	01.64
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	00.90	01.21	01.42	01.72
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	00.75	01.04	01.39	01.66
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	00.82	01.19	01.41	01.69
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	00.89	01.22	01.42	01.75
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ varmiwash	1.00	1.33	1.46	1.90
T14	Farmer practice NPK 80:60:60 kg/ha	00.66	00.93	1.00	1.19
	SEm±	00.02	00.05	00.08	00.12
	CD (P=0.05)	00.08	00.15	00.24	00.37

*WAT = Week after transplanting

Data recorded at 5th WAT showed that leaf width of different treatments ranged from 0.93 cm to 1.36 cm. The maximum leaf width (1.36 cm) was recorded in T1 followed by T13 (1.33 cm) and T3 (1.30 cm). The minimum leaf width (0.93 cm) was recorded in T14.

At 6th week after transplanting, leaf width differ significantly and it was ranging from 1.00 cm to 1.59 cm. The maximum leaf width was recorded in T1 (1.59 cm) which was statistically at par with T12 (1.57 cm) followed by. The minimum leaf width was recorded in T14 (1.00 cm).

Data recorded at 7th WAT showed that leaf width of different treatments ranged from 1.19 cm to 1.89 cm. The maximum leaf width was recorded in T1 (1.96 cm), which was found at par with other treatments i.e. T13 (1.90 cm) and T3 (1.89 cm). Whereas, minimum leaf width was recorded in T14 (1.19 cm). The maximum width of onion leaves was found in 100% of recommended dose of fertilizer followed by Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ Varmi wash. Increase in leaf area with optimum level of chemical fertilizer and integrated use of organic manures, bio-fertilizers with chemical fertilizers over farmer practice could be due to good growth of plants which enhanced by the production of bioactive substances having similar.. Similar finding were also reported by Sreenivasa (2011) [11].

Collar thickness (cm)

The collar thickness of onion recorded at 30, 60 and 90 days after transplanting is given in Table 4.5 and illustrated through Fig. 4.5. The collar thickness is one of the important growth parameter which indicates the vigour of plant and it was significantly influenced by the different treatments of organic substances.

The maximum collar thickness (4.02 cm) was recorded under T1 at 30 days after transplanting which was at par with T14 (4.00 cm), T3 (3.87 cm) and T12 (3.82 cm). The minimum collar thickness was recorded under T14 (2.47 cm).

At 60 days after transplanting, the maximum collar thickness (5.20 cm) was recorded under T1 and it was found at par with T3 (5.17 cm), T13 (5.15) cm), T2 (5.08 cm), T3 (5.17 cm), T4 (5.03 cm), T4 (5.11 cm), T9 (4.91 cm), T10 4.93 cm), T11 (4.98 cm) and T12 (5.00 cm) The minimum collar thickness was recorded under T14 (03.47cm).

In case of 90 days after transplanting, the maximum collar thickness (6.38 cm) was recorded under T1 and it was found at par with T3 (6.28 cm) and T13 (6.26 cm). While, the minimum collar thickness was recorded under T_{14} (4.44 cm).

Table 4.5: Effect of integrated nutrient management and bio enhancer on Collar thickness (cm) at different interval of onion

Treatment no	Treatment	30	60	90
T1	RDF (100:80:80 kg/ha)	04.02	05.20	06.38
T2	50% RDF+ FYM @15 t/ha	03.73	05.08	06.18
T3	50% RDF + VC@5t/ha	03.87	05.17	06.28
T4	25% RDF+ FYM @20 t/ha	03.62	05.03	06.12
T5	25% RDF + VC@7.5t/ha	03.68	05.11	6.20
T6	FYM @ 30 t/ha	2.99	03.98	4.79
T7	Varmi compost @ 10 t/ha	2.98	04.00	4.88
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60, 75 and 90 DAP	03.12	03.72	05.87
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	03.32	04.91	05.52
T10	FYM @ 10 t/ha + Madka Khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	03.43	04.93	05.87
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	03.82	04.98	05.98
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	03.92	05.00	06.01
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya + varmiwash	04.00	05.13	06.26
T14	Farmer practice NPK 80:60:60 kg/ha	02.47	03.47	04.44
	SEm±	00.25	00.36	00.29
	CD (P=0.05)	00.77	01.01	00.90

The collar thickness was maximum in recommended fertilizer dose might be due to availability of optimum quantity of essential nutrients, resulting better photosynthesis. Similar result were also obtained by Sreenivasa (2011) [11]. Application of organic substance with 75% of recommended dose of fertilizers also influenced the collar thickness and it may be due to increased growth parameters.

Yield and quality characters

Polar diameter of bulb (cm)

The data of polar diameter of bulb recorded in different treatments are presented in Table 4.6 and Fig 4.6.

The polar diameter of bulb showed significant difference for different treatments. Among the evaluated treatments numerically maximum polar diameter was recorded in T1 (5.23 cm) which was statistically at par with T3 (5.19 cm) and T13 (5.19 cm). However minimum polar diameter was recorded in the T14 (3.42 cm).

Equatorial diameter of bulb (cm)

The data of equatorial diameter of bulb recorded for different treatments are presented in Table 4.6 and Fig 4.6.

The equatorial diameter of bulb varied from 4.76 cm to 5.41 cm. The result indicated that the maximum equatorial diameter of bulb was noted in T1 (5.41 cm), which was found at par with T3 (5.33 cm) & T13 (5.18 cm). Whereas, minimum equatorial diameter of bulb was noted in T5 (4.76 cm).

Significantly higher bulb diameter was recorded under 100% of RDF followed by 50% RDF + VC@5t/ha and Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ Varmi wash. It might be due to optimum dose of fertilizers (recommended dose of NPK) which encourage the growth and development of onion bulbs, whereas application of chemical fertilizers with organic substances which increases the availability and uptake of nutrient.

Higher levels of inorganic substances/fertilizers significantly influenced the bulb equatorial and polar diameter which determines the bulb weight. Similarly, increased bulb equatorial diameter with the application of higher levels of inorganic was obtained by Sankar *et al.* (2009) [20] and Reddy (2005) [17] and the bulb polar diameter by Setty (1988), Sankar *et al.* (2009) [21] and Reddy (2005) [17].

Table 4.6: Effect of integrated nutrient management and bio enhancer on polar diameter (cm), equatorial diameter (cm), neck thickness (cm) and average weight of bulb (g) at different interval of onion

Treatment no	Treatment	Yield Parameters			
		Polar diameter (cm)	Equatorial diameter (cm)	Neck thickness (cm)	Average weight of bulb (g)
T1	RDF (100:80:80 kg/ha)	5.23	5.41	1.65	66.98
T2	50% RDF+ FYM @15 t/ha	5.00	5.23	1.43	58.48
T3	50% RDF + VC@5t/ha	5.19	5.31	1.52	64.15
T4	25% RDF+ FYM @20 t/ha	4.73	5.11	1.24	50.39
T5	25% RDF + VC@7.5t/ha	4.90	5.13	1.04	52.48
T6	FYM @ 30 t/ha	3.63	4.60	0.94	36.81
T7	Varmi compost @ 10 t/ha	3.86	4.98	0.98	39.54
T8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60, 75 and 90 DAP	4.29	4.80	1.01	48.8
T9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	4.90	4.90	1.08	54.23
T10	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	4.93	4.90	1.17	56.92
T11	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	5.00	5.03	1.23	58.12
T12	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	5.09	5.09	1.3	59.27
T13	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ varmiwash	5.18	5.18	1.49	64.76
T14	Farmer practice NPK 80:60:60 kg/ha	3.42	4.76	0.98	37.98
	SEm±	00.12	00.09	00.06	03.63
	CD (P=0.05)	00.36	00.27	00.20	11.02

Neck thickness of bulb (cm)

It is clear from the Table 4.6 and Fig 4.6 that the neck thickness of different treatments differed significantly and ranged from 0.98 cm to 1.65 cm. The maximum neck thickness was recorded in T1 (1.65 cm), which was at par with T3 (1.52 cm) & T14 (1.49 cm). Whereas, minimum neck thickness was recorded in T14 (0.98 cm).

Average weight of bulb (g)

It is clear from Table 4.6 and Fig 4.6 that the average bulb weight of all the treatments under study were differs significantly and ranged from 37.98 g to 66.98 g. The maximum weight of bulb was noted in T1 (66.98 g), which was found statistically at par with T3 (64.15g) and T13 (62.12 g). Whereas, minimum weight of bulb was recorded in T_{14} (37.98 g).

The average bulb weight were recorded higher under T1, T3 and T13 and it may be due to recorded higher polar and equatorial diameter in the same treatments which determines the bulb weight.

The maximum bulb weight was recorded under 100% of RDF, 50% RDF + VC@5t/ha and Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ Varmi wash this may be due to optimum availability of NPK fertilizers, increases the rate of metabolism and synthesized more carbohydrate thus increases bulb yield. Similar results were also reported Sankar *et al.* (2009) [21].

Bulb yield of onion differed significantly due to different organic manure combination and bio-enhancer. In the present study, this increased yield might be due to increased yield attributing characters like weight of the bulb, polar and equatorial diameter. The present results are in confirmation with the findings of in brinjal and in okra. Further, it is relevant to note that, farm yard manure seems to be directly responsible in increasing crop yields by accelerating the respiratory process which increasing cell permeability with hormone acceleratory growth and combination of all these processes. It supplies nitrogen, phosphorus, potassium of which phosphorus involved in cell division, photosynthesis and metabolism of carbohydrates where potash regulated proper translocation of photosynthesis and stimulated enzyme activity which increased the rate of growth and positive development in yield characters which is resulted in high bulb yield of onion. Similar finding was also reported by Sankar *et al.* (2009) [20] in onion.

Increased bulb weight with increased inorganic levels was also reported by Bagali *et al.* (2012) [3].

4.2.1 Marketable bulb yield (t/ha)

The data regarding marketable bulb yield recorded in different treatments are presented in Table 4.7 and Shown in Fig 4.7.

The marketable bulb yield differed significantly and varied from 16.44 t/ha to 35.04 t/ha. The maximum marketable bulb yield was recorded in T1 (35.04 t/ha), followed by T3 (33.98t/ha) and T13 (33.36 t/ha). However minimum marketable bulb yield was recorded in T14 (16.44t/ha).

Total yield (t/ha)

The data regarding total bulb yield of onion were significantly differed in different treatments are presented in Table 4.7 and Shown in Fig 4.7.

The total bulb yield varied significantly from 21.44 t/ha to 39.57 t/ha. The maximum total yield was recorded in T1 (39.57 t/ha), which was at par with T7 (31.87 t/ha) followed by T6 (28.85 t/ha). Whereas, minimum total yield was recorded in T14 (21.44 t/ha).

The maximum yield i.e. 39.57 t/ha was recorded under 100% RDF. The optimum level of inorganic fertilizers significantly increased the growth parameters and yield attributing characters and enhanced good growth and development may be due to better nutrient availability and uptake by crop.

The next highest bulb yield were recorded under 50% RDF + VC@5t/ha fallowed by Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ Varmi wash and it may be due to major nutrient supplied by inorganic fertilizers will be utilized quickly and other essential nutrients available in organic substances will be released slowly.

The combination of two nutrient sources helped to increased growth parameters and yield contributing characters resulting good bulb yield. Similar result was also obtained by Sankar *et al.* (2005) [20] in onion crop. Similar results are also found by who reported that the yield was found highest with 100 kg nitrogen/ha.

Table 4.7: Effect of integrated nutrient management and bio enhancer on Marketable bulb yield (t/ha) and Total yield (t/ha) at different interval of onion

Treatment no	Treatment	Yield parameters	
		Marketable bulb yield (t/ha)	Total yield (t/ha)
T_1	RDF (100:80:80 kg/ha)	35.04	39.57
T_2	50% RDF+ FYM @15 t/ha	28.85	31.02
T_3	50% RDF + VC@5t/ha	31.87	36.98
T_4	25% RDF+ FYM @20 t/ha	26.98	30.07
T_5	25% RDF + VC@7.5t/ha	27.08	30.58
T_6	FYM @ 30 t/ha	17.95	26.53
T_7	Varmi compost @ 10 t/ha	20.96	27.87
T_8	FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60, 75 and 90 DAP	23.23	28.34
T_9	Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	26.29	28.66
T_{10}	FYM @ 10 t/ha + Madka khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	29.02	31.63
T_{11}	Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP	30.16	33.78
T_{12}	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya	31.02	33.50
T_{13}	Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit + irrigation with Jevamrit + foliar spray of Panchgavya+ Varmiwash	33.36	35.36
T_{14}	Farmer practice NPK 80:60:60 kg/ha	16.44	21.44
	SEm±	01.42	01.03
	CD (P=0.05)	04.31	03.14

Economics

The economics of all the treatments are given in Table 4.10 and Appendix II. The net profit/ha ranged from Rs. 75979.80/ha to Rs. 135669.05/ha. The maximum net profit/ha was recorded under T1 (Rs. 135669.05/ha). While minimum net profit/ha was obtained in T14 (Rs. 75979.80/ha).

The gross profit/ha ranged from Rs. 107200.00/ha to Rs. 174350.00/ha. The maximum gross profit/ha was recorded in T1 (Rs. 174350.00/ha). Whereas, minimum gross profit/ha was recorded in T14 (Rs. 107200.00/ha). Thus, the maximum income (both gross and net) was obtained with T1 and the lowest income (both gross and net) was obtained with T0.

5. Conclusions

The experiment was laid out in randomized block design (RBD) in three replications with fourteen treatments viz. T1 - RDF (100:80:80 kg/ha), T2-50% RDF+ FYM @15 t/ha, T3-50% RDF + VC@5t /ha, T4-25% RDF+ FYM @20 t/ha, T5-25% RDF + VC@7.5t/ha, T6- FYM @ 30 t/ha, T7-Varmi compost @ 10 t/ha, T8-FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T9-Varmi compost @ 5 t/ha + FYM @ 10 t/ha + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T10-FYM @ 10 t/ha + Madka Khad + foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T11-Varmi compost @ 5 t/ha + FYM @ 10 t/ha +Matka Khad+ foliar spray of Panchgavya @ 3% at 30, 45, 60,75 and 90 DAP, T12- Varmi compost @ 2.5 t/ha+ Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya, T13-Varmi compost @ 2.5 t/ha + Seed treatment + Bijamrit+ irrigation with Jevamrit+ foliar spray of Panchgavya + Varmi wash, T_{14}- Farmer practice NPK 80:60:60 kg/ha. The experiment findings based on observations viz. plant height, number of leaves/plant, leaf length, leaf width, collar length, collar thickness, polar diameter, equatorial diameter, average bulb weight, neck thickness, total soluble solids, different grades of bulbs, marketable bulb yield and total bulb yield.

The plant height differed significantly in all the treatments at three distinct interval at 30, 60 and 90 DAT. The maximum plant height was found with T1 at 60 and 90 DAT *i.e.* 45.91cm and 52.28 cm respectively, while lowest plant at 30, 60 and 90 DAT were noted with T_{14} 28.21cm, 32.61 cm and 45.83 cm.

The number of leaves differ significantly at 30, 60 and 90 DAT. The mean value indicated that the number of leaves/plant was recorded maximum in 30, 60 and 90 DAT with T1 (07.03), T5 (7.80) and T4 (08.73) respectively. While, it was minimum (05.09, 05.67 and 07.22) under farmer practice.

The leaf length observation showed overall growth scenario of the treatments. The maximum leaf length was produced by the T1 (39.27cm). While, minimum leaf length was measured in T14 (30.85 cm) at 7th week after transplanting.

The maximum leaf width was recorded in the T1 (1.96cm). Whereas, minimum leaf width was measured of in T14 (1.19 cm) at 7th week after transplanting.

The collar thickness of the plant varies significantly and the T1 (6.38 cm) produced thickest collar. While, in T_{14} farmer practice (4.44 cm) was recorded thinnest collar at 90 DAT.

The polar and equatorial diameter of the bulb showed the external view of the bulb. It differed from treatment to treatment and showed the capability of the particular treatment to produce certain kind of bulb. The treatment T1 (5.23 cm and 5.41 cm) produced higher polar and equatorial diameter. The minimum polar and equatorial diameters were recorded with T14 (3.42 cm and 4.76 cm) respectively.

The maximum neck thickness recorded in T1 (1.65 cm), whereas minimum neck thickness was found in T_{14} (0.98 cm).

The average weight of bulb recorded maximum with the T1 (66.98 g) which was found statistically at par with T3 (64.15g) and T13 (64.76g). Whereas, the minimum weight of bulb recorded with T14 (37.98 g).

The marketable bulb yield differed among the treatments. The T1 (35.04 t/ha) produced maximum marketable yield followed by T3 (33.98 t/ha) and T13 (33.36 t/ha). While, the minimum marketable yield was recorded in the treatment T14 (16.44 t/ha).

The total bulb yield was recorded higher in T1 (39.57 t/ha) which was at par with T13 (33.86 t/ha) followed by T3 (31.87 t/ha).However, lowest total yield was recorded in T14 (21.44 t/ha).

The economical evaluation indicated that the highest net return and benefit: cost ratio was associated with in T1 of Rs. 135669.05/ha and 4.5, respectively and lowest net return was found in T14 Rs. 75979.80/ha and lowest B:C ratio (2.37) in T3.

Suggestion for future work

On the basis of the experience gained and results obtained, following suggestions are made for future line of work:

The present results are based on the one season study. Hence, it should be repeated for one more season to conformity of the result so that definite recommendation could be made for a suitable treatment for higher yield of onion.

As the investigation was carried out only at KY more plateau condition for adoptability of entire region, it is necessary to test the treatments at other regions also.

Other organic nutrients sources like poultry manure, sheep manure, press mud and leguminous crops may be utilized for production of onion.

Different plant extracts and bio agents which are having antimicrobial properties may be tried for extension of storage life.

Complete organic production technology is to be developed.

6. References

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