EFFECT OF DIFFERENT COMBINATION OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH AND YIELD OF ONION UNDER PROTECTED CONDITION

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ABSTRACT

Onion productivity in Nepal remains below the global average, largely due to imbalanced and inefficient fertilizer management. To address this, a field experiment was conducted under protected conditions at the College of Natural Resource Management (CNRM), Bardibas, Mahottari, to evaluate the effect of different combinations of organic and inorganic fertilizers on the growth and yield of onion (Allium cepa L.) *cv. 'Nasik Red'. The experiment was carried out in Completely Randomized Design with eight treatments : control, 100% inorganic nitrogen + 100% FYM, 100% FYM, 100% vermi compost, 50% inorganic nitrogen and 50% FYM, 50%inorganic nitrogen + 25% FYM + 25% vermi- compost, 25% inorganic nitrogen + 75% FYM, 25% inorganic nitrogen + 75% vermi- compost with three replications.Growth parameters (plant height, leaf number and chlorophyll content) and yield attributes (bulb weight, bulb diameter, biomass and yield) were recorded and statistically analyzed using ANOVA at a 5% significance level. Results revealed that fertilizer treatments significantly influenced plant height, bulb weight, and total yield, whereas effects on leaf number,chlorophyll content, bulb diameter and harvest index were statistically non-significant. The highest plant height (62.92 cm), bulb weight (43.6 g), and maximum yield (15.36 t ha^{-1}) were obtained with 100% vermicompost, followed closely by 25% inorganic N + 75% FYM. The control treatment consistently recorded the lowest values for all growth and yield parameters. However, economic analysis showed that despite superior biological performance, 100%*

vermicompost had the lowest benefit–cost ratio (0.38) due to high input costs. In contrast, 100% FYM exhibited the highest economic return (B:C = 2.66). The study concludes that while vermicompost enhances onion productivity under protected conditions, 100% FYM is the most economically viable option in soils with adequate native nitrogen and phosphorus. The findings highlight the importance of integrated nutrient management for sustainable and profitable onion production in Nepal. It can be further tested in farmer field for validation and recommendation.

***Keywords*:** *Vermi compost, SPAD meter, Chlorophyll content, Integrated nutrient management, Bulb yield*

INTRODUCTION

Onion (*Allium cepa* L.) is one of the widely cultivated vegetable of family Alliaceae. It is a widely cultivated crop which is second after tomato, and widely cultivated crop in different cultures worldwide (FAO, 2012). Onion bulb is a rich source of nutrients and also possess good medicinal properties (Bari & Noori, 2012). Onion is commonly cultivated in more than 130 countries at present with the largest global producers of onion including China, India, the US and Turkey (Ochar & Kim, 2023). Onion is the second most valuable vegetable crop worldwide after tomato (FAO, 1996). In Nepal, the cultivation of onion ranges from mid-hills to terai. Onion is cultivated in an area of 13,189 ha with production of 1,66,904 mt/ha in Nepal whereas production and yield is 2,128mt and 14mt/ha respectively in Bardibas, Mahottari (Ministry of Agriculture and Land Development (MoALD), 2078). However, productivity is 17.3 mt/ha in the world (Gelaye et al., 2024) which is higher in comparison to that of Nepal. The color, flavor, and scent of onions are caused by a variety of phytomolecules, including polyphenolic chemicals, phenolic acids, flavonoids (fisetin, quercetin) (1-4), ascorbic acid, and sulfur compounds (5, 6) (Dorrigiv et al., 2021). Onion is referred as "Queen of the kitchen" due to its highly prized aroma, scent, unique taste and the therapeutic properties of its flavouring ingredients (Ali et al., 2024).

Low soil fertility, among many other factors, limits the production and nutritional value of onions. As with other food crops, the decline in onion yields has led farmers to amend the soils with various organic materials to provide the nutrients required to improve crop growth and yield (Bari & Noori, 2012). Incorporation of both organic and inorganic fertilizers is important for proper growth and good production of onions. Organic fertilizer like farmyard manure is a natural source of important plant nutrients such as nitrogen, phosphorus and potassium. Organic matter improves soil's physical, chemical, biological properties and is also effect the availability of nutrient (Yoldaş, 2020). Synthetic fertilizers often show good result initially due to quick supply of concentrated nutrients but the continuous application of inorganic fertilizers gradually creates an imbalance in soil microbial ecosystem, disrupts soil structure and its physical property and degrades the land eventually. Decomposition of organic materials provides additional nutrients to the growing medium, which subsequently leads to higher uptake of nutrients by the crop resulting in higher yield (Gererufael et al., 2020). Use of inorganic fertilizers continuously without supplementation with organic manure often results in micronutrient deficiencies, imbalance soil physical and chemical properties and unsustainable crop production (Gererufael et al., 2020).

Vermi compost is an another form of organic fertilizer obtained through the decomposition of organic wastes along with earthworm's excreta. Vermi compost which is produced by the action of the earthworms *Lampito mauritii, Eudrilus eugeniae, Perionyx excavatus*, and *Eisenia foetida*, utilizes their capacity to convert organic matter such as manure, coffee husks and plant residues into a compost by the action of their digestive systems (Luu et al., 2024). It aids in enhancing the soil's physical properties with better water retention capacity, reduced nutrient leaching, slow release of nutrients which favors better growth of plant for long term. Plant height, number of leaves, number of tillers, individual plant weight and plot yield were positively affected after addition of vermi compost to spring onion (Luu et al., 2024).

Nitrogen is an important macronutrient essential for the growth of plants. Balanced application of nitrogen increases crop yield, improves crop quality, supports microbial activity, enhances photosynthesis and energy transfer. For both growth and productivity of all plants and onion crops, nitrogen is an important element (Al-Fraihat, 2009). With only limited research conducted on integrated use of organic and inorganic fertilizers, this research aims to assess the effect of different combinations of organic and inorganic forms of fertilizers in onions under a poly house.

MATERIALS AND METHODS

The experimental area is located at the southern belt i.e, terai region of Nepal which has tropical climate. It was conducted in the field of College of Natural Resource Management, Bardibas, Mahottari (26°56'35"N 85°53'21"E) in poly house. A polyhouse is a protected cultivation structure covered with transparent or semi-transparent material, such as polyethylene, that allows partial control of the internal microclimate. Onion commonly called 'Pyaj' in Nepali language is one of the major vegetable crop grown in almost every household from hills to terai region on Nepal.

Soil physical properties, fertility status and pH were evaluated prior to the initiation of experiment. The soil on the experiment plot was sandy loam in texture with high N and P and medium K content. Soil was found to be slightly acidic with pH 5.5.

The experiment was conducted using Completely Randomized Design consisting of three replications with eight treatments. The treatments were formulated using different proportions of the recommended dose. Nitrogen was applied at three levels, namely 25%, 50% and 100% of the recommended dose of urea while phosphorus and potassium were applied at 100% of recommended dose through MoP (Muriate of Potash) and DAP (Diammonium Phosphate) respectively. Similarly, organic manures like four different doses of FYM (25%, 50%, 75%, 100% of recommended dose) and three of vermicompost (25%, 75%, 100% of recommended dose) were administered at various combination. One of the treatment was control where there was no application of fertilizer. The following Table 1 shows the details of the treatment.

Table 1. Details of treatments with their combinations

Treatment	Treatment combinations
T1	Control
T2	100% Urea + 100%FYM
T3	100% FYM
T4	100% Vermicompost
T5	50% Urea + 50% FYM
T6	50% Urea + 25% FYM + 25% vermi compost
T7	25% Urea +75% FYM
T8	25% Urea + 75% vermi compost

Sixty two days old seedlings of Nasik variety were transplanted into the plot in total area of 2m*1.25m with row to row spacing of 15cm and plant to plant of 10cm on 13th December, 2023. The total area of one replication was 5.55m*4.25m. The recommended doses of fertilizer were applied at the rate of 20t/ha FYM, 15t/ha vermi compost (Bari & Noori, 2012). As well as NPK at the rate of 300:200:200 kg/ha (Singh & Bhandari, 2019) were applied. Full dose of P and K with ½ dose of N were applies at the time of transplanting. Rest of the half dose of N was applied in two split doses. First half was top dressed 30 days after transplanting and second half at 60 days after transplanting. Vermicompost and FYM were applied at basal dose. After a week of transplanting, gap filling was done to replace dead and unestablished seedling with new ones. Intercultural operations like weeding, irrigation, hoeing were carried out evenly. At full maturity, the bulbs were harvested on 4th April, 2024.

Different growth parameters were observed and recorded at varying interval of growing period. Plant height and leaf number were recorded at 15 days interval. Similarly, at the interval of 30 days, chlorophyll content of five randomly selected plant from each plot was noted using SPAD meter. Ten plants were selected randomly from each plot and their height from ground level to the tip of the leaves was measured using measuring tape. Bulb weight, Bulb diameter (equatorial, polar), plant height with bulb and biomass were measured after harvest from ten randomly selected plants. Vernier caliper was used for the estimation of the bulb diameter.

All the recorded data was arranged systematically treatment wise under 3 replications on the basis of various observed parameters. The obtained data was tabulated in Microsoft excel and the data analysis was employed through RStudio to find out the significant difference between the mean values at 5% level of significance. The significance was determined by using the following ANOVA table.

Table 2. ANOVA summary table for a one way Completely Randomized Design

Source of variation	Degree of freedom (df)	Sum of Square (SS)	Mean Sum of Square (MS)	F- value
Treatments	t-1	SS(Treatments)	$\frac{\text{SS(Treatments)}}{\text{df(Treatments)}}$	$\frac{\text{MS(Treatments)}}{\text{MS(Error)}}$
Error	n-1	SS(Error)	$\frac{\text{SS (Error)}}{\text{df(Error)}}$	
Total	n-1	SS (total)		

RESULTS AND DISCUSSION

The effect of organic and inorganic fertilizers on growth and yield of onion were observed and recorded.

Growth parameters

Plant height

The result revealed that the treatments showed significant effects on plant height at all growth stages i.e. 15 DAT, 30 DAT, 45 DAT, 60 DAT and 75 DAT as shown in table 3, with highly significant differences observed at 75 DAT. Maximum plant height was consistently achieved by applying 100% vermicompost at recommended dose. It achieved the maximum plant height of 62.92 cm at 75 DAT, followed by 25% urea + 75% FYM (58.7 cm) and 25% urea + 75% vermi compost (59.8 cm), demonstrating the positive impact of combined organic and inorganic fertilizer application on onion growth and yield. From around 22.5 cm at 15 DAT to about 56 cm by 75 DAT, the onions grew steadily as predicted, demonstrating the importance of the vegetative period in the development of leaf structure, which tends to restrict final bulb size. Better vegetative growth in 100% vermi compost might be due to abundance of nitrate, the more readily absorbed type of nitrogen by plants, in vermi compost and comparatively fast release of it for plant use (Abou-El-Hassan et al., 2018).

Table 3. Influence of organic and inorganic fertilizers on plant height at different growth stages of onion in Bardibas, Mahottari (2023/2024)

Treatment	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT
Control	22.10^{bcd}	22.40^{d}	27.50^{c}	38.20^{c}	44.20^{d}
100% urea + 100% FYM	20.10^{d}	22.08^{cd}	29.40^{bc}	43.31^{bc}	57.20^{abc}
100% FYM	20.82^{d}	25.90^{bc}	35.10^{ab}	45.10^{ab}	54.21^{bc}
100% Vermicompost	24.51^{a}	29.20^{a}	40.42^{a}	51.10^{a}	62.92^{a}
50% urea + 50% FYM	24.20^{ab}	25.10^{bcd}	32.61^{bc}	45.82^{ab}	52.71^{c}
50% urea + 25% FYM	21.90^{cd}	25.60^{bc}	29.90^{bc}	44.30^{bc}	58.70^{ab}
+ 25% vermi compost	23.70^{abc}	26.05^{bc}	33.20^{bc}	47.61^{ab}	58.46^{ab}
25% urea + 75% FYM					
25% urea + 75% vermi compost	22.21^{bcd}	26.80^{ab}	30.40^{bc}	47.0^{ab}	59.81^{ab}
SEm	0.22	0.33	0.65	0.68	0.62
F test	**	**	**	*	***
$LSD_{0.05}$	1.95	2.90	5.62	5.91	5.32
CV, %	4.94	6.50	9.92	7.43	5.42
Grand mean	22.47	25.53	32.36	45.35	56.03

DAT: Days After Transplanting, LSD: Least Significant Difference, SEm: Standard Error of mean, CV: Coefficient of Variation; *: significant at ≤0.05 level of significance, **: significant at ≤0.01 level of significance, ***: significant at ≤0.001 level of significance,

Leaf number

With only a significant difference noted at 75 DAT, the data show that fertilizer treatments had little effect on the number of leaves over the onion's growth stages, as evidenced by non-significant F-test values at 15, 30, 45, and 60 DAT. With 100% vermi compost and 25% urea + 75% vermi compost displaying the highest values of 6.1 and

6.36 leaves, respectively at 75 DAT, while control displayed the lowest leaf count (5.33) at the final growth stage. The leaf number gradually increased from a grand mean of 2.97 at 15 DAT to 6.05 at 75 DAT across all treatments. Vermicompost and chemical fertilizers together enhanced the budget of vital soil micronutrients and stimulated the microbial community, both of which support enhanced growth including leaf number (Asgele et al., 2018).

Table 4. Influence of organic and inorganic fertilizers on leaf number at different gr owth stages of onion in Bardibas, Mahottari (2023/2024)

Treatment	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT
Control	2.80^{ab}	3.60^{b}	4.73^{a}	5.36^{b}	5.33^{c}
100% urea + 100% FYM	2.73^{b}	3.80^{ab}	4.67^{a}	5.96^{a}	6.21^{ab}
100% FYM	2.80^{ab}	4.16^{a}	4.90^{a}	5.86^{ab}	5.86^{b}
100% Vermicompost	3.23^{a}	4.03^{a}	5.03^{a}	6.10^{a}	6.0^{ab}
50% urea + 50% FYM	3.20^{ab}	3.87^{ab}	4.83^{a}	5.90^{ab}	6.13^{ab}
50% urea + 25% FYM + 25% vermi compost	3.03^{ab}	3.84^{ab}	4.50^{a}	5.90^{ab}	6.26^{ab}
25% urea + 75% FYM	3.03^{ab}	4.06^{a}	5.10^{a}	5.86^{ab}	6.26^{ab}
25% urea + 75% vermi compost	3.0^{ab}	4.03^{a}	4.73^{a}	6.13^{a}	6.36^{a}
SEm	0.05	0.04	0.07	0.05	0.05
F test	NS	NS	NS	NS	**
$LSD_{0.05}$	-	-	-	-	0.44
CV, %	8.33	5.56	7.17	4.73	4.15
Grand mean	2.97	3.925	4.82	5.88	6.05

DAT: Days After Transplanting, LSD: Least Significant Differences, SEm: Standard Error of mean, CV: Coefficient of Variation, NS: non-significant, **: significant at ≤0.01 level of significance,

Chlorophyll content

Non-significant F-test values show that fertilizer treatments had no apparent effect on chlorophyll content at 30 or 60 DAT, according to the data shown in Table 5. 50% urea + 50% FYM had the greatest values (53.84 and 51.26 SPAD) at both growth phases, whereas 50% urea + 25% FYM + 25% vermi compost had the lowest reading (34.43 SPAD) at 30 DAT. The chlorophyll content ranged from 34.43 to 53.84 SPAD units at 30 DAT and from 48.9 to 57.7 SPAD units at 60 DAT. According to studies, onion plants that receive enough nitrogen are able to absorb more of it and thus produce more chlorophyll structure (Andishmand & Noori, 2021). Application of both organic and inorganic fertilizers affects onion development and yield, explaining the overall tendency toward increasing chlorophyll content during later growth stages.

Table 5. Influence of organic and inorganic fertilizers on chlorophyll content of onion leaves in Bardibas, Mahottari (2023/2024)

Treatment	30 DAT(SPAD)	60 DAT(SPAD)
Control	41.24^{ab}	50.52^{a}
100% urea + 100% FYM	39.90^{ab}	57.71^{a}
100% FYM	50.05^{ab}	54.0^{a}
100% Vermicompost	39.20^{ab}	51.13^{a}
50% urea + 50% FYM	53.84^{a}	51.26^{a}
50% urea + 25% FYM + 25% vermi compost	34.43^{b}	52.18^{a}
25% urea + 75% FYM	46.93^{ab}	48.90^{a}
25% urea + 75% vermi compost	50.51^{ab}	51.88^{a}
SEm	1.69	1.06
F test	NS	NS
CV, %	18.70	10.01
Grand mean	44.51	52.21

DAT: Days After Transplanting, LSD: Least Significant Differences, SEm: Standard error of mean, CV: Coefficient of Variation, NS: non-significant, *: significant at ≤0.05 level of significance, **: significant at ≤0.01 level of significance, ***: significant at ≤0.001 level of significance.

Yield parameters Yield

The results showed that application of different treatments showed highly significant results i.e. at 0.1% in the yield of onions as shown in Table 6. Control recorded the lowest yield while 100% vermi compost recorded the highest yield. It indicates that in control the crop cannot express its full potential but in contrast, 100% vermicompost created the most favorable conditions among all other treatments for better crop growth and development. 25% urea + 75% FYM showed statistically similar performance to 100 % vermi compost followed by 100% urea + 100% FYM, 25% urea + 75% vermi compost, 100% FY, 50% urea + 25% FYM + 25% vermi compost and 50% urea + 50% FYM.

Bulb diameter (Equatorial and polar)

Treatments did not show any effect on bulb diameter (equatorial and polar) which means no significant differences were observed among the treatments as shown in Table 5. In equatorial bulb diameter, 25% urea + 75% FYM followed by 100% vermi compost were the highest but were not statistically better than others. Similarly, 100% vermi compost followed by 100% urea + 100% FYM and 50% urea + 50% FYM were the highest in terms of numerical value but were not statistically significant than other treatments.

Bulb weight

Significant result at 5% was observed on bulb weight of onions. 100% vermi compost outperformed other treatments in terms of bulb weight as well. It was followed by 25% urea + 75% FYM, 100% FYM, 100% FYM,50% urea + 50% FYM, 25% urea + 75% vermi compost, 50% urea + 25% FYM + 25% vermi compost, 100% urea + 100% FYM while control being the lowest.

Biomass yield

Significant result at 5% was observed on biomass yield as shown in table 6. The highest biomass yield was recorded in 50% urea + 50% FYM and 25% urea + 75% FYM with control being the lowest. It indicates that 50% urea + 50% FYM and 25% urea + 75% FYM promoted vegetative growth more effectively than other treatments.

Harvest index

None of the treatments showed significant differences in the harvest index as shown in Table 6. Despite of 100% Vermicompost having the highest harvest index among all the treatments, differences between the treatments were not statistically significant.

Table 6. Influence of organic and inorganic fertilizers on yield parameters of onion in Bradibas, Mahottari (2023/2024)

Treatment	Yield(t/ha)	Bulb diameter Equatorial (cm)	Bulb diameter Polar(cm)	Bulb weight	Biomass Yield (t/ha)	Harvest Index
Control	10.15^{e}	3.86^{b}	3.80^{b}	30.77^{c}	15.00^{c}	68.79^{a}
100% urea + 100 % FYM	13.87^{abc}	4.50^{ab}	4.41^{a}	33.62^{bc}	23.66^{ab}	60.19^{ab}
100% FYM	13.06^{bcd}	4.35^{ab}	4.24^{ab}	37.63^{ab}	24.33^{ab}	54.75^{ab}
100% vermi compost	15.36^{a}	4.62^{a}	4.51^{a}	43.62^{a}	22.00^{ab}	71.27^{a}
50% urea + 50% FYM	12.15	4.47	4.41	36.49^{bc}	25.66^{a}	48.24^{b}
50% urea + 25% FYM + 25% vermi compost	12.30^{cd}	4.19^{ab}	4.07^{ab}	33.84^{bc}	19.66^{abc}	63.27^{ab}
25% urea + 75% FYM	14.41^{ab}	4.71^{a}	4.37^{ab}	39.52^{ab}	25.66^{a}	56.44^{ab}
25% urea + 75% vermi compost	13.45^{bcd}	4.46^{ab}	3.95^{ab}	35.29^{bc}	19.00^{bc}	70.76^{a}
SEm	0.19	0.07	0.06	0.77	0.71	2.16
F test	***	NS	NS	*	*	NS
$LSD_{0.05}$	1.66	-	-	6.68	6.17	-
CV,%	7.25	8.55	7.80	10.49	16.12	17.18
Grand mean	13.09	4.39	4.22	36.35	21.87	61.71

DAT : Days After Transplanting, LSD : Least Significant Differences,SEm : Standard Error of mean, CV : Coeffecient of Variation, NS: non-significant, *: significant at ≤0.05 level of significance, ***: significant at ≤0.001 level of significance

Based on the results obtained, comparatively higher value of most of the parameters including plant height, bulb diameter, bulb weight and yield were seen in 100% vermi compost. Readily water soluble nutrients are present in vermi compost which is relatively easier for plants to absorb. "Worm mucus" present in worm casting helps to prevent nutrients from washing away during irrigation. Vermi compost increases soil fertility by boosting microbial activity and microbial biomass levels, as well as preventing the destruction of soil-borne pests and diseases. In addition to making plants healthy, qualified, and productive, it also controls plant development with humic acid and hormones (Durak et al., 2017). Vermicompost is well known for its useful effects as a soil amendment among all other organic fertilizer. During the process of vermicomposting,organic substrates are ground in digestive system after ingestion. It is biochemically digested before absorbing some of it in their body. Vermicasting is unabsorbed material excreted by earthworm and the components present in vermicompost enhance soil porosity, aeration, and soil aggregation. (Coulibaly et al., 2020). Similarly, there are various beneficial effects of farmyard manure on yield attributes of onion. It is because there is greater amount of food manufactured in plant due to enahanced supply of macro as well as micro nutrients and it ultimately increases the bulb yield (Kaswan et al., 2017). Inorganic fertilizer helps to boost growth mainly at early stages. Since nitrogen, phosphorus, and potassium are the main minerals that plants need in big quantities, applying them through inorganic fertilizers releases nutrients for healthy growth and quicker crop plant development (As et al., 2017).

Economic analysis

The production cost is divided into two parts i.e fixed cost and variable cost. Fixed cost includes the cost incurred on purchase of seed, labor and ploughing.

Fixed costs

Table 7 summarizes the costs incurred on fixed production operations for crop cultivation. It covers expenses associated with land preparation, crop establishment, intercultural operations, irrigation, harvesting, post-harvest handling and seed.

Land preparation was done by ploughing with cultivator and rotavator. The rate of ploughing a kattha of field was Rs 300 making a total of Rs 9,000 to plough 1 ha of field using a cultivator. Similarly, ploughing of a kattha of land by rotavator is Rs 400, which sums up to Rs 12,000 for 1 ha land.

Labourers were hired for transplanting with total cost of Rs 15,000, calculated at a rate of Rs 500 per kattha over 30 kattha. Weeding involved three phases. Rates were same in all weeding operations, Rs 500 per kattha, which added up to Rs15,000 for 1 ha of land resulting in a total weeding cost of Rs 45,000.

Only five labors were hired for irrigation purpose at the rate of Rs 500 labour cost per day. So, the total cost on irrigation was Rs 2,500 on 1st, 2nd and 3rd irrigation each.

The cost for harvesting was Rs 15,000 (30 kattha * Rs 500). Post-harvest operations included processing and drying, each conducted over 10 kattha at a rate of Rs 500 per kattha, with respective costs of Rs 5,000.

In addition, a fixed expenditure of Rs 18,000 was recorded for seed. When aggregated, the total cost incurred on fixed factors of production amonted to Rs 1,31,500.

Table 7. Cost incurred on fixed factors of production of onion in Bardibas, Mahottari (2023/2024)

	Area(kattha)	Rate	Total cost (Rs)
Ploughing		300	9,000
Cultivator	30		
Rotavator	30	400	12,000
Transplanting	30	500	15,000
Weeding		500	15,000
1st	30		
2nd	30	500	15,000
3rd	30	500	15,000
Irrigation		500	2,500
1st	5		
2nd	5	500	2,500
3rd	5	500	2,500
Harvesting	30	500	15,000
Processing	10	500	5,000
Drying	10	500	5,000
Seed			18,000
		Total	1,31,500

Variable costs

Variable cost includes cost of fertilizers used which varied with different treatments. The prevailing price per kg of urea, DAP, MOP, FYM and vermicompost were Rs 20, Rs 55, Rs 65, Rs 20 and Rs 25 respectively. The cost of fertilization for control was zero. For 100% inorganic nitrogen + 100% FYM the cost summed up to Rs 70280. In 100% FYM the cost to Rs 45,960. Similarly cost of fertilization for 100% vermicompost, 50% inorganic nitrogen+50% FYM, 50% inorganic nitrogen+25% FYM + 25%

vermicompost, 25% inorganic nitrogen + 75% FYM and 25% inorganic nitrogen + 75% vermicompost were Rs 4,20,460, Rs 2,47,876, Rs 1,46,626.6, Rs 3,46,626.6 and Rs 3,27,876.6 respectively. Highest variable cost was seen in 100% vermi compost whereas there was no any cost for control as shown in Table 8.

Table 8. Cost incurred on variable factors of production in Bardibas, Mahottari (2023/2024)

Treatment	Cost of fertilizer(Rs)
T1	0
T2	70,280
T3	45,960
T4	4,20,460
T5	2,47,876
T6	1,46,626.6
T7	3,46,626.6
T8	3,27,876.6

The data presented in Table 9 illustrates the economic performances of treatments in terms of yield, market rate, income, total cost of cultivation, net income and benefit-cost (B:C) ratio for each treatment. Yield varied substantially among treatments, ranging from 7.1t/ha in control to 15.3 t/ha in 100% vermi compost, indicating notable differences in productivity. The selling price remainted constant at Rs 50,000 per ton across all treatments. Consequently, gross income was directly proportional to yield, with the highest income recorded in 100% vermi compost (Rs 7,65,000) and the lowest in control (Rs 3,55,000). Total production cost varied in various treatments from Rs 1,31,500 in control to Rs 5,51,960 in 100% vermicompost, reflecting differences in input use and management practices. Net income also differed markedly among treatments, with the highest net return obtained in 100% urea + 100% FYM (Rs 4,88,220), followed closely by 100% FYM (Rs 4,72,540), while control recorded the lowest net income (Rs 2,23,500). The benefit-cost ratio ranged from 0.38 to 2.66, demonstrating wide variation in economic efficiency. Control, 100% urea+100%FYM, 100%FYM and 50% urea+ 25% FYM+ 25% vermi compost showed B:C ratios greater than 1.0 which can be referred as economically profitable, whereras 100% vermicompost, 50% urea+ 50% FYM, 25% urea + 75% FYM and 25% urea + 75% vermi compost with B:C ratios below 1.0, resulted in financial losses. Among all treatments, 100% FYM emerged as the most economically efficient, having the highest B:C ratio (2.66) along with a high net income.

On the contrary, 100% vermi compost despite producing the highest yield and gross income, showed the least B:C ratio due to its high production cost.

Table 9. Net benefit obtained at various treatments of onion in Bardibas, Mahottari (2023/2024)

Treatment	Yield (t/ha)	Rate (per ton)	Income (Rs)	Total cost (Rs)	Net income(Rs)	B:C
1	7.1	50,000	3,55,000	1,31,500	2,23,500	1.69
2	13.8	50,000	6,90,000	2,01,780	4,88,220	2.41
3	13	50,000	6,50,000	1,77,460	4,72,540	2.66
4	15.3	50,000	7,65,000	5,51,960	2,13,040	0.38
5	12.1	50,000	6,05,000	3,79,376	2,25,624	0.59
6	12.3	50,000	6,15,000	278126.6	3,36,873.4	1.21
7	14.4	50,000	7,20,000	4,78,126.6	2,41,873.4	0.50
8	13.4	50,000	6,70,000	4,59,376.6	2,10,623.4	0.45

CONCLUSION

Application of organic amendments, particularly vermicompost and Farm Yard Manure (FYM) improved vegetative growth, bulb development, and total yield compared to the unfertilized control. Among all treatments, 100% vermicompost produced the highest plant height, bulb weight, and yield, indicating its strong positive effect on soil fertility, nutrient availability, and plant performance. However, agronomic superiority did not translate into economic superiority. Due to the high cost of vermicompost, this treatment showed the lowest benefit–cost ratio, making it financially impractical for most farmers. In contrast, 100% FYM provided a favorable balance between yield and profitability, achieving the highest B:C ratio (2.66) while maintaining good agronomic performance. Therefore, for soils already rich in nitrogen and phosphorus, sole application of FYM along with recommended doses of phosphorus and potassium represents the most sustainable and economically feasible nutrient management strategy for onion cultivation under protected conditions in Bardibas, Mahottari.

RECOMMENDATIONS

On the basis of agronomic performance and economic evaluation, several recommendations can be drawn from the present study. The application of 100% farmyard manure (20 t ha^{-1}) in combination with the recommended doses of phosphorus

(200 kg ha^{-1}) and potassium (200 kg ha^{-1}) is suggested for achieving optimum onion production. Vermicompost may be considered as an alternative nutrient source where it is locally available at a lower cost or in high-value organic production systems; however, its exclusive use is not economically viable under prevailing market conditions. In situations where the availability of FYM is limited, an integrated approach involving moderate levels of inorganic nitrogen in combination with FYM (e.g., 25% nitrogen plus 75% FYM) may serve as a feasible alternative strategy. Furthermore, the findings of this study should be validated under open-field conditions across multiple seasons and agro-ecological locations in Nepal. Long-term investigations are also recommended to evaluate the effects of repeated application of FYM and vermicompost on soil health, nutrient accumulation, and residual fertility.

REFERENCES

Abou-El-Hassan, S., Elmehrat, H. G., Ragab, A. A., Abo-Dahab, A. M. M. A., & Megiud, A. (2018). Growth, yield, bulb quality and storability of some onion cultivars response to compost, vermicompost and plant growth promoting rhizobacteria. *Middle East Journal of Agriculture Research*, 7(2), 292-306.

Al-Fraihat, A. (2009). Effect of Different Nitrogen and Sulphur Fertilizer Levels on Growth, Yield and Quality of Onion (*Allium cepa* L.). *Jordan Journal of Agricultural Sciences, 5*(2)*,* 155-165.

Ali, I. I., Ahmed, I. A., Kheire, A. M., Abdi, A. W. M., Hassan, I. A., Ibrahim, I. A., ... & Abdullahi, Y. M. (2024). Comparative study of the effects of organic and inorganic fertilizers on the growth and yield of onion (*Allium cepa* L.) in Somalia. *International Journal of Agricultural and Natural Sciences*, *17*(1), 100- 110.

Andishmand, A. B., & Noori, M. S. (2021). Growth and yield of onion (*Allium cepa* L.) as influenced by application of organic and inorganic fertilizers. *Journal of Scientific Agriculture*, *5*, 55–59.

Adeyeye, A. S., Ishaku, M., Godu, H. O., Olalekan, K. K., & Lamid, W. A. (2017). Comparative effect of organic and inorganic fertilizer treatments on the growth and yield of onion (Allium cepa L.). *Research & Reviews: Journal of Botanical Sciences,* 6(2), 8-11.

Asgele, K., Woldetsadik, K., & Gedamu, F. (2018). Effect of inorganic NP fertilizers and vermicompost on growth, seed yield and yield components of onion (*Allium cepa* L.) at Maitsebri, Northern Ethiopia. *Journal of Horticulture and Forestry*, *10*(6), 89–96.

Bari, A. K. M., & Noori, M. (2012). Growth and yield of onion (*Allium cepa* L.) as influenced by application of organic and inorganic fertilizers. *Journal of Scientific Agriculture*, *5,* 55–59. https://doi.org/10.25081/jsa.2021.v5.7270

Coulibaly, S. S., Ndegwa, P. M., Soro, S. Y., Koné, S., Amoin, E., Kouamé, A., & Zoro Bi, I. (2020). Vermicompost application rate and timing for optimum productivity of onion (*Allium cepa* L.). *International Journal of Agriculture and Agricultural Research*, *16*, 38–52.

Dorrigiv, M., Zareiyan, A., & Hosseinzadeh, H. (2021). Onion (*Allium cepa* L.) and its Main Constituents as Antidotes or Protective Agents against Natural or Chemical Toxicities: A Comprehensive Review. *Iranian Journal of Pharmaceutical Research : IJPR*, *20*(1), 3–26. https://doi.org/10.22037/ijpr.2020.112773.13940

Durak, A., Altuntas, O., Kutsal, I., ışık, R., & Karaat, F. (2017). The Effects of Vermicompost on Yield and Some Growth Parameters of Lettuce. *Turkish Journal of Agriculture - Food Science and Technology*, *5*, 1566. https://doi.org/10.24925/turjaf.v5i12.1566-1570.1461

Gelaye, Y., Nakachew, K., & Ali, S. (2024). A Review of the Prospective Effects of Spacing and Varieties on Onion Yield and Yield Components (*Allium cepa* L.) in Ethiopia. *The Scientific World Journal*, *2024*, 2795747. https://doi.org/10.1155/2024/2795747

Gererufael, L. A., Abraham, N. T., & Reda, T. B. (2020). Growth and yield of onion (*Allium cepa* L.) as affected by farmyard manure and nitrogen fertilizer application in Tahtay Koraro District, Northwestern Zone of Tigray, Ethiopia. *Vegetos*, *33*(4), 617-627.

Kaswan, P. K., Yadav, P. K., Jakhar, R. K., Kumawat, A., & Kumar, H. (2017). Effect of Different Varieties and FYM Levels on Yield and Quality of Onion (*Allium cepa* L.) in Arid Western Rajasthan, India. *International Journal of Current Microbiology and Applied Sciences*, *6*(6), 497–503. https://doi.org/10.20546/ijcmas.2017.606.058

Luu, H., Le, L., & Green, I. (2024). Effects of vermicompost on the growth and yield of spring onion (*Allium fistulosum* L.). *Journal of Agricultural Sciences Belgrade*, *69*, 31–44. https://doi.org/10.2298/JAS2401031L

Ochar, K., & Kim, S.-H. (2023). Conservation and Global Distribution of Onion (*Allium cepa* L.) Germplasm for Agricultural Sustainability. *Plants*, *12*(18), Article 18. https://doi.org/10.3390/plants12183294

Singh, K.P., & Bhandari, R. R. (2019). *Vegetable crops production technology.* Samiksha Publication.

Yoldaş, F. (2020). Residual Effect of Organic Manure and Recommended NPK Fertilizer on Yield and Bulb Performance of Onion (Allium cepa L.) as Second Crop Under Greenhouse Conditions. *Applied Ecology and Environmental Research.* 18(1), 303-314.