Nutrient Management Practices in Mulching and Non-mulching Conditions of Okra (Abelmoschus Esculentus) in Arghakhanchi District

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Abstract: An experiment was conducted to assess the response of okra (*Abelmoschus esculentus* L. Moench) to different sources of nutrients under mulched and non-mulched condition in Arghakhanchi, Nepal. The effect of three different sources of nutrient (Chemical Fertilizer, FYM, Poultry) and control with mulching and non-mulching condition were studied using two Factorial Randomized Complete Block Design with three replications each containing 8 plots. Hybrid variety of okra (Arka anamika) mostly used by farmers in Arghakhanchi was used as a test crop. Data were collected from five randomly selected plants from the central rows in each plot. The results revealed that those two factors significantly affected growth and yield parameters. As the data were analyzed, higher plant height at 30 DAS was found in Chemical fertilizer. Number of leaves, Fruit number, and plant diameter at initial observation were found higher in both Poultry Manure and Chemical fertilizer. However, at the later observations all the growth and yield were found higher in Poultry Manure (12.5t ha^{-1}). Highest individual fruit weight was found 14.61 g and highest individual fruit length was found 14,35 cm. Poultry Manure has more nutrient content, rapid mineralization, optimum C/N ratio, growth promoting substances leading to better growth and yield. Poultry manure is a rich stable source of organic nitrogen, forms proper soil aggregates, conserves moisture and is in ha1rmony with the environment too. Mulching showed better results in germination, plant height, number of leaves and fruits, plant diameter and yield. This is because plastic mulches absorb comparatively large amount of the incoming radiation; raising temperature, also conserving moisture, reducing weed competition and providing favorable environment for microorganisms.

Keywords: Okra, FYM, Poultry Manure, Control, Mulching

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1. Introduction

Okra (*Abelmoschus esculentus (L). Moench),* is one of the major vegetable crops grown in tropical and sub-tropical regions of the world. It is herbaceous annual plant, surviving only one growing season belonging to the family Malvaceae. This crop can be cultivated as a garden crop and also can be produced on large commercial farms. India ranks first in the world with 3.5 million tons (70% of the total world production) of okra produced from over 0.35million hectare land (Food and Agriculture Organization Corporate Statistical Database, 2008). It is valued for its tender pods that can be consumed as a fried or boiled or may be added to salads, soups and stews.

Being one of the most popular vegetables in our country it is widely grown in Jhapa, Morang, Saptari, Dhanusha, Mohattari, Rautahat, Bara, Chitwan and Kailali. Total production of okra across the country was 122,101.6 metric tons under the area of 10,781.4ha with the productivity of 11.3t/ha (Ministry of Agriculture and Development, 2015). Total production and productivity of okra is seriously affected by the use of low yielding local varieties, sub optimal plant density, planting date, soil fertility, serious infestation of pests and weeds, mosaic virus etc. Optimum plant density (spacing) is the key element for higher yield of okra, as plant growth and yield are affected by inter and intra-row spacing (Zibelo, Wtsadik, & Sharma, 2016). Maintaining optimum plant population and nitrogen fertilization dose are most important elements in improving productivity of okra. In most vegetable crops, appropriate plant spacing results in better vegetative growth and copious yield whereas too high or low plant densities may not give satisfactory quality and quantity (Paththinige, Abeykoon, Fonseka, &

Weerasinghe, 2010). With increasing plant population, yield per unit area increases until a certain limit, beyond which yield decreases due to limitation of environmental resources required for plant growth. Further, optimum plant population is a major element responsible for higher yields of okra, as plant growth and yield are affected by intra and inter row spacing (Amjad & Anjum, 1999) . Nutrient requirements vary with production location, variety, soil type, agronomic practices etc. Nitrogen supply improves cell division and photosynthetic activity of the plant, producing higher numbers of flowers and fruits. The farmer's low yield problem is further compounded by the utilization of inappropriate spacing and fertilizer use. Even though, the agro ecological condition of country is favorable for home garden and commercial production of okra, people grow okra conventionally and no attention has so far been given for the development of improved intercultural management practices like population density and nitrogen fertilizer application to increase the productivity of the crop in the country.

2. Materials and Method

The experimental field was located in the humid sub-tropical region having elevation of 960 masl. Arghakhanchi is one of the districts of province no. 5 (Lumbini) located in the mid hills between 28° N and 29° N latitude to 81° E and 83° E longitude having an area of 1193 sq.km. The district ranges from 305-2575 m in altitude Arghakhanchi experiences tropical to Mild temperate climate with an average annual rainfall of approximately 1600 mm.

The daily maximum temperatures of the research site varied from 21˚C to 26˚C and minimum temperatures varied from 12°C to 17°C during the crop period. The rainfall during the experiment was very erratic which ranged from 0mm to 465mm per week. Hybrid variety of okra (Arka anamika) mostly used by farmers in Arghakhanchi was used as experimental crop. The primary tillage of the experimental field was carried out by mini tiller. The land was exposed to the sun for 2-3 days and the secondary tillage was carried out, during which the weeds and their residues were removed from the field. Full dose of FYM, Poultry manure, DAP, MOP and half dose of Urea were added after final land preparation to their respective plots and then plastic mulch was applied to the mulching plots. Remaining half dose of Urea was added in split doses at 20 DAS and 35 DAS.

The research was carried out to study the effect of two factors namely and nitrogen dose on the growth and yield of okra crop.

Table 1. Combination of treatment for Okra research in Sandikharka, Arghakhanchi, 2021

1	Chemical Fertilizer + Mulching	N1M1	T_1
2	Chemical Fertilizer + Non-Mulching	N1M2	T_2
3	FYM + Mulching	N2M1	T_3
4	FYM + Non-mulching	N2M2	T_4
5	Poultry Manure + Mulching	N3M1	T_5
6	Poultry Manure + Non-mulching	N3M2	T_6
7	Control + Mulching	N4M1	T_7
8	Control + Non-mulching	N4M2	T_8

Table 2. Design of experiment field

Details	Description
Design	Randomized Complete Block Design (RCBD)
Replication	3
No. of Treatments	8
Individual Plot size	2m ×1m
Total No. of Plots	24
Total no. of plants	360
No. of plants per plot	15
Spacing between plants	45cm ×45 cm
Spacing between plots	0.6m
Border spacing	1m
Spacing between Replication	1m

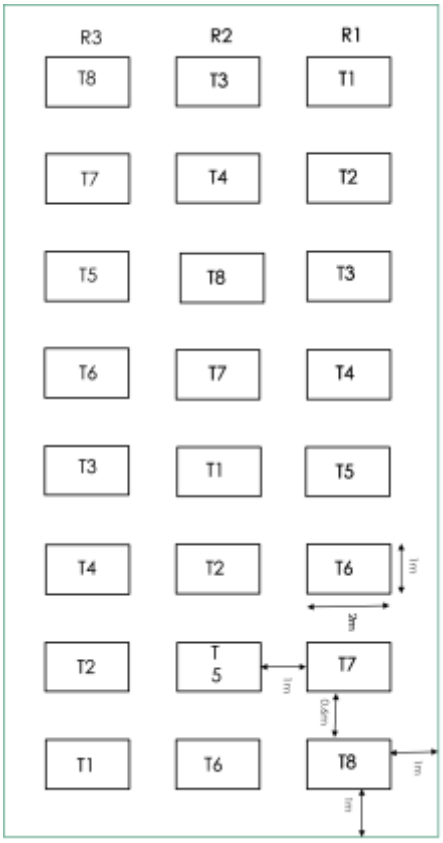

Figure 1. Layout of the research field

All the plants in each plot were observed regularly for recording data. Data was collected from 5 sample plants in each plot and following parameters were observed while data collection.

- Days to 50 % germination
- Plant height at 30 and 60 DAS
- Plant diameter at 30 and 60 DAS
- Number of leaves at 30 and 60 DAS
- Number of Fruits at 45 and 60 DAS
- Individual fruit length after harvest from 65 DAS
- Individual Fruit weight after harvest from 65 DAS
- yield

The observed data were systematically arranged in MS-EXCEL and analyzed with the help of R Studio. DMRT for mean separation at 5% level of significance was done.

3. Results and Discussion

Table 3. Influence of different sources of nutrients and mulching on germination of okra seeds at Sandhikharka, Arghakhanchi, 2021

Treatments	Days to 50 % germination
Nutrients	
Chemical	12.00[b]
FYM	13.50[a]
Poultry Manure	12.167[b]
Control	13.33[a]
SEM(+/-)	0.37
LSD(α=0.05)	1.121
CV	7.18
F test(α=0.05)	0.003107**
Grand Mean	12.75sss
Mulch	
Mulching	12.08[b]
Non-mulching	13.417[a]
SEM(+/-)	0.26
LSD(α=0.05)	0.95
CV	7.18
F test(α=0.05)	0.023905*
Grand Mean	12.75

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

Effect of different nutrients showed significant results in the days to 50% germination of okra seeds. Chemical fertilizers showed least number of days (12) for 50% seeds to germinate which was statistically at par with Poultry manure (12.16 days). Statistically FYM and control also showed similar results which were 13.5 days and 13.33 days respectively.

Mulching also showed significant results in the germination of okra. Mulching showed 50% germination of seeds at 12.08 days whereas non-mulching showed it at 13.41 days.

Table 4. Height of Okra plant as influenced by different sources of nutrient with mulching and non-mulching conditions at Sandhikhara, Arghakhanchi, 2021

Treatment	Height of okra	
	30 days	60 days
Nutrients		
Chemical	35.83[a]	81.03[b]
FYM	31.26[b]	80.90[b]
Poultry Manure	32.32[b]	82.69[a]
Control	25.03[c]	65.61[c]
Sem	0.53	0.53
LSD(α=0.05)	1.59	1.59
CV	4.12	1.68
F test(α=0.05)	4.40E-03***	1.92E-13***
Grand Mean	31.61	77.36
Mulch		
Mulching	32.54[a]	78.81[a]
Non-mulching	30.68[b]	76.90[b]
SEM(+/-)	0.37	0.37
LSD(α=0.05)	1.13	1.13
CV	4.12	1.68
F test(α=0.05)	3.52E-03**	4.64E-02*
Grand Mean	31.61	77.36

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

The effect of different nutrients and mulching both showed statistically significant influence on plant height of okra at all 2 observations (Table no. 5). At 30 DAS, the highest plant height was shown by chemical fertilizer (35.83 cm) which statistically followed by Poultry Manure (32.32 cm). Similar results was shown in an research earlier where at 30 DAS chemical fertilizer showed 26.93 cm plant height and Poultry Manure showed 24.9 cm plant height (Bhandari, et al., 2019). FYM showed statistically similar result to Poultry Manure i.e. 31.26 cm and the least plant height was shown by control i.e. 25.03 cm. Mulching showed statistically higher plant height (32.54 cm) than non-mulching (30.68cm). This result is in line with the finding of Jha et al. (2018) who reported that greater plant height was obtained in plastic mulch at 45 DAS (116.20cm) and 60 DAS (134.9) than control and other mulch.

At 60 DAS, Poultry manure had statistically highest result showing 82.69 cm plant height while the control had the least plant height measuring 65.61 cm. This finding is in line with the findings of Adhikari & Piya (2020) where at 55 DAS Poultry manure Showed 76.44 cm plant height followed by chemical fertilizer (68.5 cm), followed by FYM (65.5 cm) and the lowest was seen in control (36.94 cm). Chemical and FYM showed statistically similar results i.e. 81.03 cm and 80.90 cm respectively. Mulching had higher plant height (78.81 cm) than Non-mulching (76.9 cm).

Table 5. Number of leaves in okra plant as influenced by different source of nutrients with mulching and non-mulching conditions at Sandhikharka, Arghakhanchi, 2021

Treatments	Number of leaves	
	30 days	60 days
Nutrients		
Chemical	12.17[a]	13.10[b]
FYM	7.53[b]	12.53[b]
Poultry Manure	11.60[a]	16.40[a]
Control	7.57[b]	10.87[c]
SEM(+/-)	0.037	0.053
LSD(α=0.05)	1.54	0.78
CV	12.82	4.71
F test(α=0.05)	8.00E-06***	2.96E-08***
Grand Mean	9.72	13.47
Mulch		
Mulching	10.15	13.80[a]
Non-mulching	9.28	13.15[b]
SEM(+/-)	0.03	0.04
LSD(α=0.05)	1.09	0.55
CV	12.82	4.71
F test(α=0.05)	Ns	0.02505*
Grand Mean	9.72	13.47

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

The results showed that, at 30 DAS, the average number of leaves was 9.72. Chemical treatment had the highest number of leaves on the plant (12.17) which is statistically at par with Poultry manure (11.6). This finding is in line with the findings of Bhandari, et al. (2019) where statistically similar results were obtained in the number of leaves from chemical fertilizer (8.33) and Poultry Manure (8.66). Statistically, FYM and control both showed the least number of leaves in plant (7.53 and 7.56 respectively). Mulching showed a slightly greater number of leaves (10.15) than non-mulching (9.28) however the result was not significant.

At 60 DAS, the average number of leaves was 13.47. Both Nutrients and Mulch had a significant influence on leaf number at 60 DAS. Poultry manure showed a significantly highest number of leaves (16.40) than the rest of the nutrient treatments, Chemical treatment, and FYM were seen as statistically similar showing 13.10, and 12.53 leaves respectively. Control showed the least number of leaves i.e. 10.87. On the other hand, mulching showed higher leaf number (13.8) than non-mulching (13.15).

Table 6. Fruit number of okra plant as influenced by different source of nutrients with mulching and non-mulching conditions at Sandhikharka, Arghakhanchi, 2021

Treatments	Fruit Number	
	45 DAS	60 DAS
Nutrients		
Chemical	6.90[a]	10.47[b]
FYM	5.93[b]	9.33[c]
Poultry Manure	6.73[a]	11.55[a]
Control	4.27[c]	8.23[d]
SEM(+/-)	0.16	0.31
LSD(α=0.05)	0.51	0.93
CV	6.92	7.74
F test(α=0.05)	9.57E-08***	0.000105***
Grand Mean	5.96	9.74
Mulch		
Mulching	6.03	10.73[a]
Non-mulching	5.88	8.75[b]
SEM(+/-)	0.12	0.22
LSD(α=0.05)	0.36	0.66
CV	6.92	7.73
F test(α=0.05)	Ns	1.61E-05***
Grand Mean	5.96	9.74

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

The results showed that at 45 DAS, the average fruit number in an Okra plant was 5.96. The highest fruit number was shown by Chemical treatment and Poultry Manure i.e. 6.9 and 6.73 respectively which are statistically at par with each other. FYM showed 5.93 number of fruits while the least number of fruits was shown by control (4.27). On the contrary, results were not significant in the case of mulching and non-mulching condition.

At 60 DAS, Nutrients and mulching both had significant influence over fruit number. The average number of fruits was found to be 9.745. Poultry Manure represented a statistically higher result; 11.55 which was followed by Chemical fertilizer i.e. 10.47. This finding is in line with an experiment performed in Chitwan (Bhandari, et al., 2019). Adekiya, et al. (2020) also reported that Poultry manure showed a higher Fruit number per plant compared to FYM and NPK fertilizers. FYM had an average fruit number of 9.33 and the least number of fruits was shown by control i.e. 8.23. In the case of second factor, a higher result was shown by mulching i.e. 10.73 fruits as compared to non-mulching (8.75 fruits).

Table 7. Diameter of Okra plant as influenced by different sources of nutrient with mulching and non-mulching conditions at Sandhikharka, Arghakhanchi, 2021

Treatments	Diameter	
	30 DAS	60 DAS
Nutrients		
Chemical	2.25[a]	3.13[ab]
FYM	2.03[b]	2.83[bc]
Poultry Manure	2.22[a]	3.21[a]
Control	2.02[b]	2.59[c]
SEM(+/-)	0.51	0.26
LSD(α=0.05)	0.11	0.16
CV	4.27	4.53
F test(α=0.05)	0.000522***	3.79E-06***
Grand Mean	2.13	2.94
Mulch		
Mulching	2.19[a]	3.01[a]
Non-mulching	2.07[b]	2.87[b]
SEM(+/-)	0.36	0.18
LSD(α=0.05)	0.08	0.12
CV	4.27	4.52
F test(α=0.05)	0.004122**	0.02191*
Grand Mean	2.13	2.94

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

The diameter of the okra plant was significantly influenced by both Nutrients and mulching on both days of observations. The average diameter of okra plant at 30 DAS was found to be 2.13 cm. The highest diameter of okra plant was shown by Chemical fertilizer (2.25 cm) and a similar result was shown by Poultry Manure (2.22 cm). Similar results were reported by Bhandari, et al. (2019). FYM and control also showed statistically similar results; 2.03 cm and 2.02 cm respectively. Mulching showed statistically better influence on plant diameter (2.19 cm) over non-mulching (2.07 cm).

At 60 DAS, the average diameter of okra plant was found 2.94 cm. Poultry Manure showed a 3.21 cm diameter of plant which was statistically highest among the rest, Chemical manure showed statistically similar results with PM i.e. 3.13 cm. FYM showed statistically similar results with Chemical fertilizer i.e. 2.83 cm. The least diameter of plant was shown by control (2.59cm). Mulching showed statistically higher results (3.01 cm) over non-mulching (2.87 cm).

Table 8. Yield attributes of okra as influenced by different source of nutrients with mulching and non-mulching condition at Sandhikharka, Arghakhanchi, 2021

Treatments	Individual Fruit Length (cm)	Individual Fruit weight(g)
Nutrients		
Chemical	13.40[b]	13.18[b]
FYM	11.40[c]	11.88[c]
Poultry Manure	14.35[a]	14.61[a]
Control	9.39[d]	9.68[d]
SEM(+/-)	0.17	0.29
LSD(α=0.05)	0.55	0.88
CV	3.56	5.86147
F test(α=0.05)	5.43E-11***	9.57E-08***
Grand Mean	12.13	12.34
Mulch		
Mulching	12.28	12.50
Non-mulching	11.98	12.17
SEM(+/-)	0.12	0.21
LSD(α=0.05)	0.37	0.62
CV	3.56	5.86
F test(α=0.05)	Ns	Ns
Grand Mean	12.13	12.34

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

Different sources of nutrient showed significant influence on the individual fruit length as well as weight of Okra whereas mulching did not show any significant results. The average individual fruit length of Okra was found to be 12.13cm. Statistically highest Individual fruit length was found to be 14.35 cm shown by Poultry Manure which was followed by Chemical fertilizer (13.4 cm) and then by FYM (11.4 cm). Least fruit length was shown by control i.e. 9.39 cm. Similar results were reported by Adhikari & Piya (2020). The average individual fruit weight was found 12.34 g. Highest individual fruit weight was shown by Poultry Manure (14.61 g) followed by Chemical fertilizer (13.18 g). Least individual fruit weight was shown by control (9.68 g).

Table 9. Yield of okra as influenced by different source of nutrients with mulching and non-mulching condition at Sandhikharka, Arghakhanchi, 2021

Treatments	Yield (kg/ha)
Nutrients	
Chemical	11361.33[b]
FYM	8151.50[c]
Poultry Manure	12550.50[a]
Control	6623.50[d]
SEM(+/-)	241.26
LSD(α=0.05)	731.79
CV	6.11
F test(α=0.05)	1.83E-10***
Grand Mean	9671.7
Mulch	
Mulching	10079.33[a]
Non-mulching	9264.08[b]
SEM(+/-)	170.59
LSD(α=0.05)	517.45
CV	6.11
F test(α=0.05)	0.004496**
Grand Mean	9671.7

*Note SEM: Standard error of mean, LSD: Least Significant Difference, CV: Coefficient of Variation, DAS: Days after Sowing, Ns: Non-significant, *** denotes significant at 0.001P level, ** denotes significant at 0.01P level, *denotes significant at 0.05 P level, Treatment mean followed by common letters are not significantly different from each other based on DMRT 5% significance*

Yield of okra was significantly influenced by both nutrients and mulching. The average yield of Okra was found to be 9671.7 kg/ ha. Highest yield was given by Poultry manure i.e., 12550.5 kg/ ha which was followed by chemical fertilizer (11361.33 kg/ha). FYM showed an intermediate result with 8151.5 kg/ha and least yield was shown by control i.e., 6623.5kg/ha. Similar results were found in Malaysia by Adekiya et al. (2020) in which six different treatments (no fertilizer, NPK fertilizer, poultry manure, rat manure, goat manure and rabbit manure) were investigated on the growth and yield of okra. According to the study, treatment including poultry manure significantly increased the growth and yield performances of okra compared to other treatments. Adhikari & Piya (2020) and Bhandari, et al (2019) also reported similar results. On the other hand, higher yield was shown by mulching (10079.33 kg/ha) than non-mulching (9264.083 kg/ha). Similar results were reported by Jha and his team in 2018.

4. Conclusion

Chemical fertilizer was found to have better vegetative growth in the early half of the experiment but in the later half reproductive parameters (individual fruit weight, length, and yield) were found better in poultry manure. Early germination, higher plant height, higher fruit number, and yield was in mulched plot than in non-mulched ones. The combined effect of nutrient management and mulching on plant growth and production was not significant. Although Chemical fertilizer showed better results in a few parameters and may have shown higher yield if was not subjected to leaching by rainfall, it is still not advisable as it decreases the soil fertility and causes soil dryness. Indiscriminate use of inorganic fertilizers decreases nutrient uptake, poor quality of vegetables, and deterioration of soil health. Poultry manure is a rich stable source of organic nitrogen, has a higher carbon-nitrogen ratio, forms proper soil aggregates, conserves moisture, and is in harmony with the environment too. Mulching was better not just for higher yield but

also saves time and labor, maintaining soil temperature, providing favorable conditions for microorganisms, and better moisture conservation.

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