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Impact of Fertilizer Levels on The Growth and Yield of Onion *(Allium cepa L.)* Under Jatropha *(Jetropha curcasL.)* Based Agroforestry System

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ABSTRACT
In order to investigate the effect of different levels of fertilizers application on Onion (Allium cepa), a field experiment was conducted at the Forest Nursery, College of Forestry, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj U. P. India, to evaluate theeffect of different levels of fertilizers on the growth and yield of onion under Jatropha based Agroforestry system. A total of nine treatments were replicated three times both under shade and open conditions. Plant height (cm), Number of leaves/ plant, Neck thickness (cm), Fresh weight of bulb (g), Dry weight of bulb (g), Bulb size in diameter (cm) and Bulb yield (t/hectare) in both open and under Jatropha were found to be maximum in T_4 (NPK 165:100:110 kg/ha) and minimum in T_9 (NPK 190:125:135kg /ha).
Keywords: Agroforestry system, Jatropha, Dry weight of bulb, Onion

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INTRODUCTION

Forest in India is under unbearable biotic pressure and deforestation is taking place at an alarming rate which is estimated to be 1.3 m ha per year [1]. Agro forestry is a collective terms for all land use systems and practice in which woody plants (tree/shrubs) are deliberately combined with herbaceous crops and /or animals on the same land management unit with some form of spatial arrangement or in sequence [2] .

Only 20 percent of the total land area is under forest, ranging from 3.8 percent in Pakistan to about 70 percent in Bhutan. It isestimated that the actual area under vegetal cover may be only half of that reported. Besides the need forincreasing food production to feed the increasing population of the subcontinent, the urgency of meeting fuel, fodder and timber requirements and preserving the ecological and environmental balance cannot be understated. Agroforestry has a long tradition in the Indian subcontinent. The socio-religious fabric of the people of thesubcontinent is interwoven to a very great extent with rising, caring for and respecting trees. Trees are integratedextensively in the crop- and livestock-production systems of the region according to the agro climatic and other local conditions [11].

Mineral fertilizers play an important role of onion plant growth and productivity. Many investigatorsreported that the vegetative growth of onion plants and minerals uptake was increased with increasing thelevel of NPK- fertilizers. On the other hand, we can say that continuous usage of inorganic fertilizers affectssoil structure. Hence, organic fertilizers can serve as alternative to mineral fertilizers as reported by [6] for improving soil structure.

Organic matter such as sheep and chicken manure, improves soil physical and chemical properties that are important for plant growth. Application of organic fertilizer increased the biomass yield of the main crop [10].

Onion is due to improper utilization of fertilizers and growing unsuitablevarieties under the agro climatic conditions of an area.Optimum fertilizers application for onion and cultivation ofsuitable varieties in specific environment are necessary forobtaining good yield of onion. Nitrogen plays an importantrole to reach the optimum yield of onion and is foundessential to increase the bulb size and yield [8]**.**

The oil is mainly used as biodiesel for energy. The cake can use for fish or animal feed, biomass feedstock to power electricity plants or as biogas or high- quality organic fertilizer. It can also use as a bio- pesti9cide and for medicinal purposes. When crushed, the resulting oil from the seed can be processed to produce a high- quality biodiesel that can be used in a hard diesel engine [2].

MATERIAL AND METHODS

The present investigation was conducted at Research Farm, College of Forestry, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj (U.P.) during *Rabi* season of 2015-16. The experimental farm falls under the Indo-gangetic alluvial tract of Central Uttar Pradesh. The farm was well laid out and irrigated by tube well. The experiments were conducted in a Randomized Block Design replicated thrice. There were nine treatments involving different NPK levels. Nitrogen was applied in the form of urea in two equal splits *i.e.,* as basal dose and subsequent dose at flowering stage. Phosphorus and potassium were applied as a basal dose only in the form of SSP and MOP respectively. The soil of the experimental field was well leveled. The fertility status and textural class of the soil were judged by chemical, physical and mechanical analysis. For purpose, soil samples were taken randomly from 5 places of experimental plot from the depth of 15 cm. just before sowing and fertilizer application. The soil of these samples was mixed thoroughly and a representative soil sample was drawn. The quantity of soil sample was reduced to about one kg through quartering technique.

RESULTS AND DISCUSSION

The results of the investigation, regarding the growth and development of Onion under Jatropha based Agroforestry system have been presented.

Plant Height (cm)

Table 2, indicated that the plant height at 30 DAS was higher in open condition as compared to under Jatropha due to shade condition. The highest plant height was observed in T_4 with 12.93 cm (NPK 165:100:110 kg/ha) in open and 7.87 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 12.53 cm (NPK 160:95:105 kg /ha) in open and 7.53 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum plant height was found in $T_{9\ both}$ in open and under Jatropha condition with 9.17 cm (NPK 190:125:135kg /ha) and 6.33 cm (NPK 190:125:135kg /ha) respectively.

At 60 DAS, it was observed that the plant height was higher in open condition as compared to under Jatropha due to shade condition. The highest plant height was observed in T_4 with 21.50 cm (NPK 165:100:110 kg/ha) in open and 14.33 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 21.02 cm (NPK 160:95:105 kg /ha) in open and 14.07 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum plant height was found in T_9 both in open and under Jatropha condition with 19.23 cm (NPK 190:125:135 kg /ha) and 12.33 cm (NPK 190:125:135 kg /ha) respectively.

At 90 DAS, it was observed that the plant height was higher in open condition as compared to under Jatropha due to shade condition. The highest plant height was observed in T_4 with 33.50 cm (NPK 165:100:110 kg/ha) in open and 27.63 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 32.77 cm (NPK 160:95:105 kg /ha) in open and 27.47 cm (NPK 160:95:105kg /ha) under Jatropha condition. The minimum plant height was found in T_9 both in open and under Jatropha condition with 31.40 cm (NPK 190:125:135 kg /ha) and 26.50 cm (NPK190:125:135 kg /ha) respectively

At 120 DAS, it was observed that the plant height was higher in open condition as compared to under Jatropha due to shade condition. The highest plant height was observed in T_4 with 53.33 cm (NPK 165:100:110 kg/ha) in open and 41.77 cm (NPK 165:100:110 kg

/ha) under Jatropha condition followed by T_3 with 52.57 cm (NPK 160:95:105 kg /ha) in open and 41.27 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum plant height was found in T_9 both in open and under Jatropha condition with 51.30 cm (NPK 190:125:135 kg /ha) and 40.07 cm (NPK 190:125:135 kg /ha) respectively.Similar findings were reported by Naik, *et al.* [7]**.**

Table 1 Plant height of Onion (*Allium cepa*) on different level of fertilizers under open and shade condition at 30, 60, 90 and 120 days.

Treatments	Plant height (cm) Open Condition				Plant height (cm) Shaded Condition			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1	11.73	19.60	31.63	51.60	6.57	14.33	27.53	40.50
T_2	11.77	20.07	32.03	51.67	6.125	13.53	27.40	41.27
T_3	12.53	21.07	32.77	52.57	7.53	14.07	27.47	41.27
T_4	12.93	21.50	33.50	53.33	7.87	14.33	27.63	41.77
T_5	12.47	20.125	32.37	52.50	7.33	14.27	27.53	41.60
T_6	11.30	19.57	31.60	51.53	6.50	12.63	26.57	40.20
T_7	9.40	19.53	31.53	51.37	6.40	13.40	26.83	40.40
T_8	9.30	18.57	31.10	51.27	6.37	12.77	26.77	40.37
T_9	9.17	19.23	31.40	51.30	6.33	12.33	26.50	40.07
C.D. at (5%)	**0.25**	**0.59**	**0.47**	**0.45**	**0.43**	**0.42**	**0.31**	**0.26**

No. of leaves

Table 2, indicated that the number of leavesat 30 DAS was higher in open condition as compared to under Jatropha due to shade condition. The highest number of leaves was observed in T_4 with 3.73 (NPK 165:100:110 kg/ha) in open and 3.77 (NPK 165:100:110 kg /ha) under Jatropha condition followed by $T_3$with 3.63 (NPK 160:95:105 kg /ha) in open and 3.67 (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum number of leaves was found in T_9both in open and under Jatropha condition with 3.17 (NPK 190:125:135 kg /ha) and 2.37 (NPK 190:125:135 kg /ha) respectively.

At 60 DAS, it was observed that the number of leaves was higher in open condition as compared to under Jatropha due to shade condition. The highest number of leaves was observed in T_4 with 5.73 (NPK 165:100:110 kg/ha) in open and 4.77 (NPK 165:100:110 kg /ha) under Jatropha condition followed by $T_3$with 5.47 (NPK 160:95:105 kg /ha) in open and 4.57 (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum number of leaves was found in T_9 both in open and under Jatropha condition with 4.30 (NPK 190:125:135 kg /ha) and 3.80 (NPK 190:125:135 kg /ha) respectively.

At 90 DAS, it was observed that the number of leaves was higher in open condition as compared to under Jatropha due to shade condition. The highest number of leaves was observed in T_4 with 7.60 (NPK 165:100:110 kg/ha) in open and 7.50 (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 7.57 (NPK 160:95:105 kg /ha) in open and 7.37 (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum number of leaves was found in T_9 both in open and under Jatropha condition with 6.27 (NPK 190:125:135 kg /ha) and 6.20 (NPK 190:125:135 kg /ha) respectively

At 120 DAS, it was observed that the number of leaves was higher in open condition as compared to under Jatropha due to shade condition. The highest number of leaves was observed in T_4 with 9.57 (NPK 165:100:110 kg/ha) in open and 8.80 (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 9.53 (NPK 160:95:105 kg /ha) in open and 8.73 (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum number of leaves was found in T_9 both in open and under Jatropha condition with 8.53 (NPK 190:125:135 kg /ha) and 8.17 (NPK 190:125:135 kg /ha) respectively.Similar findings were reported by Yadav, *et al.* [12].

Table 2 Number of leaves per plant of Onion (*Allium cepa*) on different level of fertilizers under open and shade condition at 30, 60, 90 and 120 days.

Treatments	No. of Leaves/plant (Open condition)				No. of Leaves/Plant (Shade condition)			
	30DAS	60DAS	90DAS	120DAS	30DAS	60DAS	90DAS	120DAS
T_1	3.40	4.50	6.125	9.27	2.80	4.33	6.47	8.47
T_2	3.47	4.77	6.77	9.30	2.90	4.30	6.40	8.40
T_3	3.63	5.47	7.57	9.53	3.67	4.57	7.37	8.73
T_4	3.73	5.73	7.60	9.57	3.77	4.77	7.50	8.80
T_5	3.50	5.40	7.27	9.50	3.60	4.40	7.53	8.67
T_6	3.37	4.40	6.33	8.77	2.73	4.20	6.33	8.33
T_7	3.30	4.33	6.37	8.73	2.63	4.23	6.40	8.37
T_8	3.23	4.43	6.63	9.23	2.50	4.10	6.30	8.20
T_9	3.17	4.30	6.27	8.53	2.37	3.80	6.20	8.17
C.D. at (5%)	**0.24**	**0.33**	**0.22**	**0.25**	**0.31**	**0.22**	**0.26**	**0.25**

Neck Thickness (cm)

Table 3, indicated that the neck thickness at 30 DAS,was higher in open condition as compared to under Jatropha due to shade condition. The highest neck thickness was observed in T_4 with 0.42 cm (NPK 165:100:110 kg/ha) in open and 0.39 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by $T_3$with 0.41 cm (NPK 160:95:105 kg /ha) in open and 0.38 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum neck thickness was found in T_9 both in open and under Jatropha condition with 0.31 cm (NPK 190:125:135 kg /ha) and 0.30 cm (NPK 190:125:135 kg /ha) respectively.

At 60 DAS, it was observed that the neck thickness was higher in open condition as compared to under Jatropha due to shade condition. The highest neck thickness was observed in T_4 with 0.80 cm (NPK 165:100:110 kg/ha) in open and 0.72 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 0.79 cm (NPK 160:95:105 kg /ha) in open and 0.125 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum neck thickness was found in T_9both in open and under Jatropha condition with 0.71 cm (NPK 190:125:135 kg /ha) and 0.59 cm (NPK 190:125:135 kg /ha) respectively.

At 90 DAS, it was observed that the neck thickness was higher in open condition as compared to under Jatropha due to shade condition. The highest neck thickness was observed in T_4 with 1.09 cm (NPK 165:100:110 kg/ha) in open and 1.08 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by $T_3$with 1.07 cm (NPK 160:95:105 kg /ha) in open and 1.06 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum neck thickness was found in T_9both in open and under Jatropha condition with 1.01 cm (NPK 190:125:135 kg /ha) and 0.99 cm (NPK 190:125:135 kg /ha) respectively.

At 120 DAS, it was observed that the neck thickness was higher in open condition as compared to under Jatropha due to shade condition. The highest neck thickness was observed in T_4 with 1.48 cm (NPK 165:100:110 kg/ha) in open and 1.38 cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 1.46 cm (NPK 160:95:105 kg /ha) in open and 1.36 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum neck thickness was found in T_9both in open and under Jatropha condition with 1.39 cm (NPK 190:125:135 kg /ha) and 1.30 cm (NPK 190:125:135 kg /ha) respectively.Similar findings were reported by [4].

Table 3 Neck thickness (cm) of Onion (*Allium cepa*) on different level of fertilizers under open and shade condition at 30, 60, 90 and 120 days.

Treatments	Neck Thickness (Cm) (Open condition)				Neck Thickness (Cm) Shade condition			
	30DAS	60DAS	90DAS	120DAS	30DAS	60DAS	90DAS	120DAS
T_1	0.37	0.76	1.04	1.43	0.34	0.64	1.04	1.33
T_2	0.38	0.77	1.05	1.44	0.35	0.67	1.05	1.34
T_3	0.38	0.77	1.05	1.46	0.38	0.125	1.06	1.36
T_4	0.42	0.79	1.07	1.48	0.39	0.72	1.08	1.38
T_5	0.42	0.80	1.09	1.47	0.37	0.68	1.05	1.35
T_6	0.39	0.78	1.06	1.42	0.33	0.63	1.03	1.32
T_7	0.34	0.73	1.02	1.40	0.32	0.62	1.02	1.31
T_8	0.33	0.72	1.01	1.41	0.32	0.60	1.00	1.31
T_9	0.31	0.71	1.01	1.39	0.30	0.59	0.99	1.30
C.D. at (5%)	**0.03**	**0.02**	**0.03**	**0.03**	**0.02**	**0.02**	**0.03**	**0.03**

Fresh Weight of Bulb (gm)

Table 4, indicated that the fresh weight of bulb was higher in open condition as compared to under Jatropha due to shade condition. The highest fresh weight bulb was observed in T_4 with 50.125 g (NPK 165:100:110 kg/ha) in open and 47.27 g (NPK 165:100:110 kg /ha) under Jatropha condition followed by $T_3$with 50.23 (NPK 160:95:105 kg /ha) in open and 46.47g (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum fresh weight bulb was found in T_9 both in open and under Jatropha condition with 47.47 (NPK 190:125:135 kg /ha) and 41.91 (NPK 190:125:135 kg /ha) respectively. Similar findings were reported by Shedeed *et al.,* [9].

Table 4 Fresh bulb weight (g) of Onion (*Allium cepa*) on different level of fertilizers under Jatropha based Agroforestry system and open condition.

Treatments	Fresh Bulb Weight (g)	
	Open	Shade
T_1	48.63	44.83
T_2	48.73	45.60
T_3	50.23	46.47
T_4	50.125	47.27
T_5	49.47	45.66
T_6	48.47	43.97
T_7	47.90	42.40
T_8	47.77	42.35
T_9	47.47	41.91
C.D. at (5%)	**0.33**	**0.125**

Dry Weight of Bulb (gm)

Table 5, indicated that the dry weight of bulb was higher in open condition as compared to under Jatropha due to shade condition. The highest dry weight bulb was observed in T_4 with 41.60 g (NPK 165:100:110 kg/ha) in open and 35.57 g (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 40.57 g (NPK 160:95:105 kg /ha) in open and 35.33g (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum dry weight bulb was found in T_9 both in open and under Jatropha condition with 39.02 g (NPK 190:125:135 kg /ha) and 32.27 g(NPK 190:125:135 kg /ha) respectively. Similar findings were reported by Shedeed *et al.,* [9].

Table 5 Dry bulb weight (g) of different level of fertilizers on Onion (*Allium cepa*) under Jatropha based Agroforestry system and open condition.

Treatments	Dry Bulb Weight (gm)	
	Open	Shade
T_1	39.40	33.67
T_2	40.10	34.33
T_3	40.57	35.33
T_4	41.60	35.57
T_5	40.33	35.13
T_6	39.40	33.67
T_7	39.27	32.50
T_8	39.23	32.20
T_9	39.02	32.27
C.D. at (5%)	**0.27**	**0.36**

Bulb diameter (cm):

Table 6, indicated that the Bulb size in diameter was higher in open condition as compared to under Jatropha due to shade condition. The highest Bulb size in diameter was observed in T_4 with 4.63 cm (NPK 165:100:110 kg/ha) in open and 3.80cm (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 4.47cm (NPK 160:95:105 kg /ha) in open and 3.60 cm (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum Bulb size in diameter was found inT_9 both in open and under Jatropha condition with 3.20 cm (NPK 190:125:135 kg /ha) and 3.13 cm (NPK 190:125:135 kg /ha) respectively.Similar findings were reported by Jilani, *et al.* [5].

Table 6Bulb diameter (cm) of different level of fertilizers on Onion (*Allium cepa*) under Jatropha based Agroforestry system and open condition.

Treatments	Bulb diameter (cm)	
	Open	**Shade**
T_1	4.27	3.30
T_2	4.30	3.50
T_3	4.47	3.60
T_4	4.63	3.80
T_5	4.43	3.53
T_6	4.20	3.20
T_7	3.80	3.23
T_8	3.77	3.17
T_9	3.20	3.13
C.D. at (5%)	**0.25**	**0.17**

Yield (t/ ha):

Table 7, indicated that the yield was higher in open condition as compared to under Jatropha due to shade condition. The highest yield was observed in T_4 with 16.76 (t/ha) (NPK 165:100:110 kg/ha) in open and 16.27(t/ha) (NPK 165:100:110 kg /ha) under Jatropha condition followed by T_3 with 16.05(t/ha) (NPK 160:95:105 kg /ha) in open and 16.08 (t/ha) (NPK 160:95:105 kg /ha) under Jatropha condition. The minimum yield was found inT_9 both in open and under Jatropha condition with 13.2 (t/ha) (NPK 190:125:135 kg /ha) and13.03 (t/ha) (NPK 190:125:135 kg /ha) respectively[2]**.**

Table 7: Yield (t/ha) of different level of fertilizers on Onion (*Allium cepa*) under Jatropha based Agroforestry system and open condition.

Treatments	Yield (t/ ha)	
	Open	**Shade**
T_1	14.62	14.42
T_2	15.02	14.88
T_3	16.05	16.08
T_4	16.76	16.27
T_5	16.30	15.92
T_6	13.82	13.93
T_7	13.92	13.61
T_8	14.06	13.33
T_9	13.20	13.03
C.D. at (5%)	**1.25**	**1.22**

CONCLUSION

In view of the experimental results obtained during the present investigation, we conclude from the study that the treatment T_4 (NPK 165:100:110 kg/ha), emerged as the best as compared to the other fertility levels with regard to its growth and yield both in open and under Jatropha based agroforestry system .

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