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Effect of different levels of NPK fertilizers on growth and yield of Drumstick, *Moringa oleifera* (Lam)

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Abstract
A study on the effect of different levels of fertilizers (NPK) on growth and growth parameters on Drumstick, *Moringa oleifera* (Lam) was carried out at college of horticulture farm, Munirabad, Koppal for a period of three years during 2014, 2015 and 2016. Treatments involved three levels of nitrogen (N1-25, N2-52, N3-100 g/plant), phosphorous (P1-100, P2-132, P3-150 g/plant) and potash (K1-15, K2-32, K3-45 g/plant) and revealed that number of pods recorded highest in N_3: 100 g/plant (153.01) compared to the lower application rate of nitrogen at 52 and 25 grams per plant which recorded 127.63 and 99.78 pods per plant. Highest number of pods per plant was recorded consistently for all the three years in N3: 100 g/plant (153.01), P3: 150 g/plant (134.84) and K3: 45g/plant (132.47) levels. Interaction between nitrogen and potassium was found significantly superior during all the three years.

Keywords: Nitrogen, phosphorous, potassium**,** levels, growth, yield, drumstick

Introduction
Drumstick (*Moringa oleifera* Lamk) is one of the perennial vegetable crop of commercial important in southern and western parts of India. It is mainly grown for its nutrient rich tender but full grown pods, leaves and flowers, which are used for culinary preparations. The seeds yield valuable oil commercially known as "Ben oil" which is used as a lubricant for fine machinery. Drumstick is a medium size, deciduous tree grows mainly in semi-arid tropical and sub-tropical areas. It tolerates poor soil, including coastal areas but grows best in dry sandy loam soil. It is a fast growing drought resistant tree but does not tolerate frost. The plant starts bearing 6 to 8 months after planting and bears for several years. It is commercially propagated by seed and vegitativelly propagated by limb cuttings. Drumstick is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. Drumstick is said to provide seven to ten times more vitamin C than oranges, ten times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach (Rockwood *et al.*, 2013) [6]. India has the richest collection of Drumstick cultivars. India ranks first among world's Drumstick producing countries accounting for about 50% of the world's Drumstick production. Drumstick is cultivated in the southern states of Tamil Nadu, Karnataka, Kerala and Andhra Pradesh in about 14,683 ha area (Anonymous, 2020). *M. oleifera* can be grown in any tropical and subtropical regions of the world with a temperature around 25–35 ◦C. It requires sandy or loamy soil with a slightly acidic to slightly alkaline pH and a net rainfall of 250–3000 mm (Thurber *et al.*, 2010) [8].

Fertilizer management plays an important role for growth and development of crop. Optimum application of different fertilizers increases growth, development and yield of crop. According to recent trend increasing the levels of nitrogen and potassium increase the production due to increased nutrition level per unit area. (Vachhani and Patel, 1993) [9]. Fertilizer management is one of the important factors for bringing a significant increase in crop yield. In intensive cropping systems, the need to start with a very fertile soil is crucial. Large amounts of compost, well decomposed manure or mineral fertilizers will still be needed to maintain productivity at an appreciably high level (Akinbamijo *et al.*, 2004) [1]. Among the major plant nutrients, response of nitrogen and potash to drumstick crop is of great importance which is directly reflected on growth, yield and quality of drumstick crop. In the present context of higher prices of fertilizers, it is necessary to work out the optimum and economic requirement of fertilizer for drumstick crop.

Therefore, present study was conducted to study effect of different levels of NPK fertilizers on growth and yield of Drumstick.

Materials and Methods

The experiment was conducted at Vegetable block, Department of Vegetable Science, College of Horticulture, Munirabad, Koppal from 2014 to 2016 for the period of three years. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. Plants were planted at distance of 2.4 x 1.8 meters with drumstick variety Bhagya. Pruning was done on first week of May. Treatments involved three levels of nitrogen *i.e.* N1 = 25 g/plant, N2 = 52 g/plant and N3 = 100 g/plant, three levels of phosphorous P1=100 g/plant, P2=132 g/plant and P= 150 g/plant, different levels of potash *i.e.* K1 = 15 g/plant, K2 = 32 g/plant and K3= 45 g/plant with 28 treatment combinations (T1: N1: P1:K1, T2: N1: P1:K2, T3: N1: P1:K3, T4: N1: P2:K1, T5: N1: P2:K2, T6: N1: P2:K3, T7: N1: P3:K1, T8: N1: P3:K2, T9: N1: P3:K3, T10: N2: P1:K1, T11: N2: P1:K2, T12: N2: P1:K3, T13: N2: P2:K1, T14: N2: P2:K2, T15: N2: P2:K3, T16: N2: P3:K1, T17: N2: P3:K2, T18: N2: P3:K3, T19: N3: P1:K1, T20: N3: P1:K2, T21: N3: P1:K3, T22: N3: P2:K1, T23: N3: P2:K2, T24: N3: P2:K3, T25: N3: P3:K1, T26: N3: P3: K2, T27: N3: P3: K3, T28: control). FYM @ 5 kg per plant applied at the time of planting and 10 kg FYM in every year after pruning in the month of May. 50% of NPK fertilizers was applied 3 Months after planting · Remaining 50% of NPK fertilizers was applied at 6 Months after planting. Observations were recorded on randomly selected five plants for number of main and secondary branches per plant at final harvest, number of pods per plant, pod weight per plant, pod circumference, pod length and yield. The obtained data was subjected to statistical analysis using variance analysis according to Snedecor and Cochran (1990) [7]. Duncan's multiple range tests at the 5% level of probability was used to compare means of treatments by SPSS 16 software.

Results and Discussion

Number of pods per plant increased in all the treatments of fertilizers applied at different levels compared to that of untreated control at all three years of observation. The pooled data indicated that number of pods recorded highest in N_3: 100 g/plant (153.01) compared to the lower application rate of nitrogen at 52 and 25 grams plant which recorded 127.63 and 99.78 pods per plant. Application of nitrogen alone increased number of pods per plant compared to that of application of P and K at different doses. In all the treatment combination of individual fertilizers applied at different rates highest dose i.e N3 (100 g/plant), P3 (150 g/plant) & K3 (45 g/plant) in all the years recorded highest number of pods of 153.01, 134.84 and 132.47 respectively. However, there was significant difference at different doses of application within the treatment in N, P and K (Table 1). Similarly Jadhav *et al.* (2010) [5] revealed that the highest nitrogen fertilizer per plant gave significantly maximum plant height, number of branches, length of branches (cm), diameter of branches (cm), weight of pod (g), length of pod (cm), diameter of pod (cm), number of pods per tree, yield of pods per tree (kg), yield of pods (t/ha) and total soluble solids and recommended to apply 100 g nitrogen, 25 g potash and 10 Kg FYM per plant.

Pod length in different treatments varied when applied at different doses in all the years of observation. The pooled data of all the three years revealed that highest dose of fertilizers applied (N3:P3:K3) increased the pod length which recorded 60.12, 51.01 and 48.98 cm respectively. Similarly, pod length within the treatments differed significantly in all the fertilizers applied at different doses. Similarly with respect to pod weight the highest level of fertilizers applied recorded more weight compared to that of lower doses and differed significantly (Table 2 & 3).

Overall the highest number of pods per plant was recorded consistently for all the three years in N3: 100 g/plant (153.01), P3: 150 g/plant (134.84) and K3: 45g/plant (132.47) levels. Further, N3 level recorded significantly more number of pods per plant when compared to N2 (127.63) and N1 (99.78), whereas P3 and K3 levels were found on par with P2 (132.63) and K2 (128.95) levels respectively but found significantly superior over P1 (112.96) and K1 (119.00) levels respectively. However interaction between nitrogen and potassium was found significantly superior during all the three years in pooled mean. The increase in yield due to nitrogen and potash level was also reported by number of workers Yadav and Yadav (2002) [13], Yadav *et al.* (2003) [12], Yadav *et al.* (2005) [11] and Ansary *et al.* (2006) [3].

Whereas, interaction between nitrogen and phosphorous found significantly superior during second and third year. Highest biomass production per plant at the end of third year was recorded by Treatment 27 (N3P3K3) is found to be on par with T24 & T23 and is significantly superior over all other treatments (Table 4). Vignesh *et al.* (2012) [10] also reported that nitrogen is a constituent part of chlorophyll molecules which is found in the leaf. Higher application rate of NPK 100kg/ha showed higher growth than 50 and 150 kg NPK kg/ha with stem height, total height and leaf number of (10.50; 20.83 and 93.33cm) in drumstick (Igbokwe *et al.*, 2017) [4].

Finally from the results it can be concluded that for the period of three years the treatment (T27- N3: P3:K3) with application of 100 g N: 150 g P: 45 g K gave the best results in terms of growth and yield of drumstick followed by (T24 - N3: P2:K3) with application of 100 g N: 135 g P: 45 g K.

Table 1: Number of pods per plant of Drumstick at final harvest as influenced different levels of NPK fertilizers.

Fertilizers & Dose	Number of pods per plant			
	2014	2015	2016	Pooled
Nitrogen levels				
N_1: 25 g/plant	68.85	63.06	167.44	99.78
N_2: 52 g/plant	77.98	79.94	224.99	127.63
N_3: 100 g/plant	87.51	107.05	264.47	153.01
S.Em±	1.21	1.63	4.67	1.51
C.D. 0.05	3.42	4.69	14.01	4.29
P levels				
P1: 100 g/plant	73.87	72.77	192.24	112.96
P2: 132 g/plant	79.09	86.37	232.42	132.63
P3: 150 g/plant	81.38	90.91	232.23	134.84
S.Em±	1.10	1.60	4.25	1.90
C.D. 0.05	3.30	4.73	12.53	5.62
K levels				
K1: 15 g/plant	76.24	78.73	202.03	119.00
K2: 32 g/plant	79.03	84.11	223.72	128.95
K3: 45 g/plant	79.07	87.21	231.14	132.47
S.Em±	1.20	1.65	4.50	2.62
C.D. 0.05	3.00	4.60	13.95	7.84
Control	54.80	49.00	69.29	57.71
S.Em±	3.12	2.97	3.09	4.84
C.D. 0.05	9.31	8.69	9.12	14.52

Table 2: Pod length (cm) of Drumstick at final harvest as influenced different levels of NPK fertilizers.

Fertilizers & Dose	Pod length (cm)			
	2014	2015	2016	Pooled
Nitrogen levels				
N_1:25 g/plant	34.60	31.62	31.16	32.46
N_2: 52 g/plant	50.07	46.82	45.45	47.45
N_3: 100 g/plant	61.57	58.78	60.01	60.12
S.Em±	1.07	0.87	0.75	0.48
C.D. 0.05	3.00	2.52	2.25	1.46
P levels				
P1**:** 100 g/plant	43.62	39.53	38.53	40.56
P2: 132 g/plant	49.70	46.99	48.67	48.46
P3: 150 g/plant	52.90	50.70	49.42	51.01
S.Em±	1.06	0.90	0.71	0.50
C.D. 0.05	3.05	2.67	2.10	1.50
K levels				
K1**:** 15 g/plant	45.66	42.05	42.18	43.30
K2: 32 g/plant	50.15	47.13	45.99	47.76
K3: 45 g/plant	50.43	48.05	49.42	48.98
S.Em±	1.07	0.94	0.74	0.51
C.D. 0.05	3.05	2.69	2.14	1.45
Control	28.83	26.93	27.05	27.61
S.Em±	1.04	0.74	0.82	1.10
C.D. 0.05	3.09	2.24	2.44	3.28

Table 3: Pod weight per plant (Kg) of Drumstick at final harvest as influenced different levels of NPK fertilizers.

Fertilizers & Dose	Pod weight per plant (Kg)			
	2014	2015	2016	Pooled
Nitrogen levels				
N_1:25 g/plant	3.72	3.85	9.72	5.76
N_2: 52 g/plant	4.99	4.95	14.17	8.03
N_3: 100 g/plant	6.33	7.63	18.90	10.96
S.Em±	0.15	0.11	0.24	0.10
C.D. 0.05	0.47	0.32	0.65	0.25
P levels				
P1**:** 100 g/plant	4.26	4.37	11.63	6.75
P2: 132 g/plant	5.25	5.78	15.56	8.86
P3: 150 g/plant	5.53	6.28	15.60	9.14
S.Em±	0.13	0.12	0.23	0.08
C.D. 0.05	0.38	0.37	0.63	0.23
K levels				
K1**:** 15 g/plant	4.80	5.08	12.94	7.61
K2: 32 g/plant	5.02	5.58	14.64	8.41
K3: 45 g/plant	5.22	5.77	15.21	8.73
S.Em±	0.01	0.11	0.21	0.09
C.D. 0.05	0.03	0.30	0.62	0.26
Control	3.11	2.48	3.02	2.87
S.Em±	0.07	0.08	0.11	0.53
C.D. 0.05	0.23	0.24	0.33	1.59

Table 4: Effect of different levels of NPK fertilizer on biomass production/plant (kg) of drumstick at year of final harvest

Treatments	At Final Harvest			
	R 1	R2	R3	Mean (Kg)
T1	18.97	15.57	15.15	16.56
T2	16.46	18.56	15.28	16.77
T3	21.20	16.21	18.87	18.76
T4	15.78	17.00	19.42	17.40
T5	17.33	23.15	19.46	19.98
T6	22.31	19.45	18.84	20.20
T7	16.69	18.13	22.18	19.00
T8	21.89	19.73	20.42	20.68
T9	18.44	22.11	24.46	21.67
T10	19.95	22.77	20.28	21.00
T11	24.10	21.00	19.97	21.69
T12	20.26	21.49	23.89	21.88
T13	23.13	21.18	25.13	23.15
T14	24.69	28.34	29.11	27.38
T15	25.93	30.37	28.00	28.10
T16	24.55	25.23	21.62	23.80
T17	24.18	26.31	25.11	25.20
T18	25.65	24.97	27.32	25.98
T19	21.14	24.00	23.14	22.76
T20	23.02	27.00	24.23	24.75
T21	26.00	31.12	29.40	28.84
T22	29.39	28.97	32.00	30.12
T23	32.96	33.25	35.95	34.05
T24	35.00	37.50	33.04	35.18
T25	33.00	31.54	29.21	31.25
T26	31.98	33.48	36.47	33.98
T27	35.37	38.25	36.00	36.54
T28	8.15	10.71	7.24	8.70
SEM	--	--	--	1.15
CD@5%	--	--	--	3.26
CV	--	--	--	8.27

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