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Growth and Yield Performance of *Corchorus olitorius* Varieties as Affected by Nitrogen and Phosphorus Fertilizers Application

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ABSTRACT

A Pot experiments were conducted at the Department of Agronomy, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso (8º 10/N and 4º 10/E) in the first cropping season of 1999, to determine the optimum rates of each of Nitrogen and Phosphorus fertilizers application for the maximum growth and seed yield of *corchorus olitorius* plant. Two varieties of corchorus viz, Oniyaya and Amugbadu were subjected separately to five rates each of nitrogen (0, 15, 30, 45 and 60kg N ha^{-1}) and phosphorus (0, 10, 20, 30 and 40 kg P_2O_5 ha^{-1}) fertilizers. The 2 x 5 factorial experiments was fitted into a completely randomized design with six replications. The results showed that the sole application of each of N and P significantly increased the plant height, number of leaves, fresh shoots, dry matter and seed yields of corchorus above the control (in which no fertilizer was used) in the two varieties. These growth and yield attributes increased as N and P rates increased from 0 up to 45kg N ha^{-1} and 30kg P_2O_5 ha^{-1} respectively, then remained unchanged or declined at higher N and P rates. The best performance in term of shoot and seed yields was recorded for Oniyaya as compared with Amugbadu variety. It is therefore concluded that yields of corchorus in the Guinea Savanna of the South Western Nigeria could significantly be improved by the sole application of N and P fertilizers at the optimum rate of 45kg N ha^{-1} and 30kg P_2O_5 ha^{-1}, respectively.

Key words: *Corchorus olitorius*, Nitrogen, Phosphorus, Fertilizers

Introduction

Corchorus olitorius, Jew mallow, belongs to the family, Tiliaceae. It was proposed that *Corchorus olitorius* originated from South China from where it was introduced to India and Pakistan. It was however found wild in many parts of India as well as China and many parts of Australia and Africa especially in Southwestern Nigeria. The major areas of production are in the South Western parts of the country covering areas like Oyo, Ogun, Ondo and Lagos States. It is one of the most popular vegetables in every home. Consequently, it is grown in nearly all home gardens, market gardens near the city and truck gardens around the world.

Vegetables play a vital role in the improvement of nutritional status of any population. *Corchorus olitorius* is widely grown in the tropics for the viscosity of its leaves either fresh or sundried. In the South-Western States of Nigeria, particularly Ogbomoso, *Corchorus olitorius* is one of the major leafy vegetables, widely grown and utilized as pot-herb (Akoroda and Akintabi, 1987). The leaves are cooked into a thick viscous soup added to stews and eaten with starching staples (Asoegwu and Ibitoye, 1983). They are usually added to stew or soup and are rich sources of vitamins and minerals (Tindall, 1983).

It has been reported that most Nigerian leaf - vegetables are rich, good and relatively cheap sources of ascorbic acid, and minerals and that the dietary ash constituents are calcium, phosphorus and iron. The edible

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leaves of *Corchorus olitorius* on the average, contains 85-87g H_2O, 5-6g protein, 0.7g oil, 5g carbohydrate, 1-5g fibre, 250-266 Mg Ca, 4-8mg iron, 3000iu vitamin A potency, 0.1mg thiamine, 0.3mg riboflavin, 1.5mg nicontinamide and 53-100mg ascorbic acid (per 100g) (Oke, 1965, 1968).

Nutrition is an important aspect of cropping system and this includes adequate supply of essential nutrients like nitrogen (N), phosphorus (P) potassium (K), magnesium (Mg), calcium (Ca), etc to the plant. The availability of these nutrients to plant contributes a lot to its growth and yield. The availability of these essential nutrients in little amount results in poor growth and yield. While too much (especially nitrogen) in the soil may result in excessive vegetative growth at the expense of yield. Therefore adequate amount of nutrients need to be supplied to plant at the right quantity and also at the right time to favour both growth and yield.

Nitrogen and phosphorus have influence on the growth and yield of vegetables. Fertilizer studies in South Western Nigeria showed positive responses of *Corchorus olitorius* to nitrogen (NIHORT, 1986). Phosphorus is important in root development and helps hasten maturity of the fruit. Tropical soils are often low in available phosphorus and therefore require extraneous inputs of phosphorus for optimum plant growth, especially for rapid growing of annual crops such as leafy vegetables (Zapata and Axman, 1995) *Corchorus olitorius* under this study. The role of nitrogen and phosphorus in crop fertilization, leading to increased absorption of both elements can be attributed to increase top growth particularly as a result of nitrogen absorption (Olaniyi, 2000). Likewise, application of any essential element should have a marked effect on yield if the soils were deficient in the element. It is, therefore, necessary to determine the growth and seed yield performance of *Corchorus olitorius* as affected by nitrogen and phosphorus fertilizers application.

The objectives of this investigation were to determine: the best variety of Corchorus olitorius in terms of shoots and seeds yield as affected by sole application of nitrogen and phosphorus fertilizers; and the appropriate level of each of nitrogen and phosphorus fertilizer for the optimum growth and seed yield of *Corchorus olitorius*.

Materials and methods

Pot experiments were conducted in 1999 at the back of Agronomy Department, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso is on Latitude $8^0$10'N and Longitude $4^0$10'E. Temperature ranges from 28^0 to 33^0C and the humidity of this area is high (74%) all year and except in January when the dry wind blows from the North. Annual rainfall is over 1000mm (Olaniyi, 2000).

Topsoil was collected from the 5-year-old fallowed *Gliricidia sepium* plot and left to dry in the open air. The soil was later sieved using a 2mm mesh sieve. The sieved soil was transferred into black polythene bags, which were used to raise Corchorus olitorius plants. The soil was allowed to rest for two days before planting Corchorus seeds in situ.

There were 120 polythene bags arranged in 6 replicates. Each replicate consisted of 20 polythene bags, arranged in two rows with each row containing 10 polythene bags. Each replicate was separated from the next by 1m row spacing to facilitate easy movement during cultural operations.

Soil analysis for various characteristics were carried out as described below. Mechanical analysis was determined by the hydrometer method (Bouyoucos, 1951) and pH with a pH meter in 1:2 (soil: water) suspension. Nitrogen was determined by micro-kjedahl method of Jackson (1962) and available P by the Bray P-1 method (Bray and Kurz, 1945). Exchangeable cations were determined by extraction with neutral NH_4OAC. Potassium, Ca and Na in the extracts were determined using a flame photometer while Mg was determined with an atomic absorption spectrophotometer. Exchangeable acidity was determined by extracting 2.5ml portions of soil with 25mls of INKCL and 10mls of extracts titrated with 0.01 N NaOH using phenolphthalein as indicator. Organic matter was determined by wet dichromate oxidation method (Walkely and Black, 1934). Effective cation exchangeable capacity (EcEc) of each soil sample was taken as sum of the exchangeable bases (Ca, Mg, K, Na) and exchangeable acidity.

Two separate experiments were conducted simultaneously to determine the single and interactive effects of each of N and P fertilizers on corchorus varieties. There were two varietal treatments and two different single element fertilizer treatments, each at five levels. The varieties were Oniyaya variety (A) and Amugbadu variety (B); subjected separately into two different fertilizers treatments, nitrogen fertilizer in form of urea at 5 levels (0, 15, 30, 45, 60 kg N ha^{-1}) and phosphorus fertilizer in form of single super phosphate at 5 levels (0, 10, 20, 30, 40 kg P_2O_5 ha^{-1}). Each of the treatment combinations was arranged in a 2x5 factorial experiment fitted into a completely randomized design (CRD).

Before planting, the seeds were steeped in water at 97^0C for 5 seconds to improve seed germination and seedling emergence (Oladiran, 1986). Planting was done in early July, with *Corchorus olitorius* seeds of the varieties Oniyaya (A) and Amugbadu (B) procured from the Agronomy Department of the University of

Ibadan, Ibadan. The two *Corchorus olitorius* varieties seed were sown in the polythene bags with Oniyaya variety occupying the first three replicates while Amugbadu variety seeds occupied the polythene bags in the other three replicates.

Based on the results of the soil chemical analysis, fertilizer application was carried out three weeks after sowing. The application was carried out by band placement of the fertilizer treatment into drills 5 cm deep and 7.5 cm away from the plant and covering up the holes very well. Thinning of less vigorous plants was carried out two weeks after sowing. This reduced the number of plant per polythene bag to four. Wetting of seedling was done every morning at early growth stage and during the drought periods to avoid wilting and to check the growth and development. Weeds were controlled twice by hand pulling at 4 weeks after sowing and 6 weeks after sowing. Other crop management included spraying with karate at 2, 4 and 6 weeks after sowing against defoliating pests.

The growth and yield parameters collected and used to assess the response of Corchorus varieties to the fertilizer treatments were, plant height, number of leaves per plant, number of flowers per plant, shoot fresh weight per plant, shoot dry matter weight per plant, number of capsules per plant, weight of 100 seed and seed yield per hectare. For the measurements of these parameters, four plants from two pots per treatment were sampled to obtain an average. Sampling of plants for growth analysis began two weeks after sowing (WAS) and continued at two weeks' interval. The meter rule was used for the measurement of the Corchorus plant height from base to the tip of the main shoots starting from two weeks after sowing for eight weeks. The number of leaves of the sampled plants were counted and recorded for eight weeks starting from two weeks after sowing. The numbers of flowers were also counted and recorded starting from the day of flowering to 50% flowering. The fresh weight and dry weight of the harvested plants shoots were determined in the laboratory using weighing balance. The number of branches per plant at seed harvest was counted and recorded. The harvested capsules were carried to the laboratory for weighing and collection of other data.

All the data collected were subjected to analysis of variance (ANOVA) for factorial in CRD for each experiment. Means were compared using least significant difference (LSD) at the 5% level of probability.

Results and discussion

Soil analysis

The result of the soil analysis taken before the filling of the polythene bags at the onset of the experiment is presented in Table 1. The soil was sandy loam with moderate organic matter content and good moisture retaining properties. Most of the nutrients in this soil are below the critical level (Adeoye and Agboola, 1985), hence there is need for the application of soil amendments inform of inorganic fertilizers.

Table 1: Chemical and physical properties of the soil used.

Parameters	Value
PH (H_2O)	6.5
Total N (%)	1.90
Available P (mg/kg)	0.18
Exchangeable Cations (C mol/kg)	
Ca^{2+}	5.8
Mg^{2+}	4.5
K^+	0.18
Na^+	0.40
Exchangeable acidity (C mol/kg)	0.4
ECEC	6.68
Base saturation (%)	86.2
Physical Characteristics	
Sand (%)	65.5
Silt (%)	28.5
Clay (%)	6.0
Textural Class	Sandy loam

Growth parameter

Significant height and number of leaves were noted between the 2nd and 8th week after sowing for each of N and P treatment, and this may be due to the higher amount of rainfall experienced during this period which may have increased solubility of the applied nutrients leading to good response (Fagbayide, 1997). Nitrogen, variety and nitrogen by variety interaction had significant ($P \leq 0.05$) effects on corchorus plant height and number of leaves (Table 2). Average plant height and number of leaves increased as the applied N rates increases from 0 kg up to 45 kg N ha^{-1}, then declined thereafter. The increased in height and number of leaves under N treatments, reconfirmed the role of nitrogen in promoting vigorous vegetative growth in leafy vegetables (Tisdale and Nelson, 1990). This also showed that nitrogen stimulates formation of new leaves and increases the size and height of plant. Nitrogen, variety and nitrogen by variety also had significant effects on number of branches, fresh shoot and dry matter.

Table 2: Effect of different levels of Nitrogen fertilizer on the average plant height and number of leaves of *Corchorus olitorius* varieties.

		Plant Height (cm)				Number of Leaves			
	Week after sowing								
N level (kg ha^{-1})	Variety	2	4	6	8	2	4	6	8
0		4.41	9.52	15.25	18.65	5.00	9.8	13.25	15.87
15		5.06	12.25	20.87	31.31	5.25	11.25	14.25	21.37
30	Oniyaya	5.25	13.16	22.62	33.50	5.50	11.00	17.87	25.62
45		5.56	16.11	27.50	37.90	5.25	12.50	24.50	30.00
60		5.25	18.51	29.50	39.50	5.25	13.25	25.75	33.50
0		3.00	8.32	12.60	17.25	4.75	8.50	12.50	14.25
15		3.50	10.87	18.25	21.75	4.75	9.00	13.75	16.50
30	Amugbadu	3.88	11.50	19.25	25.12	4.75	10.75	14.00	19.75
45		4.05	13.0	22.20	29.87	4.75	11.50	20.00	20.25
60		4.15	15.17	24.20	31.12	5.00	12.50	20.25	20.72
LSD (0.05)									
Nitrogen (N)		0.09	0.40	1.29	0.46	ns	0.35	0.56	0.84
Variety (V)		0.06	0.25	0.81	0.29	1.17	0.22	0.36	0.53
N x V		0.01	0.1	ns	0.13	ns	0.08	0.20	0.45

yield of crops (Table 3). These measured variables increased as N rates increased up to 45 kg N ha^{-1} then remains unchanged or declined. The branches formed constituted the main frame from where flower buds developed. The optimum N rates of 45 kg N ha^{-1} observed for maximum fresh shoot and dry matter yields of corchorus was less than 70 kg N ha-1 recommended for corchorus and other leafy vegetables by Ojo and Olufolaji (1997). NIHORT (1986) also reported positive responses of *Corchorus olitorius* to N with optimum rate at 75 kg N ha^{-1}, which was contrary to the rates obtained in this study. The differences in the results might be due to the differences in the initial soil fertility status, geographical location and variety used among others. Also the reduced N rate obtained in this study will assist the farmers by reducing the cost and amount of inorganic fertilizer, and reduce the problem of nitrate contamination of underground water.

Table 3: Mean fresh shoot, dry matter yields and number of branches of *Corchorus olitorius* varieties as influenced by N applications.

N level (kg ha^{-1})	Variety	Fresh Shoot yield (g)	Dry Matter yield (g)	Number of branches
0		13.20	7.15	19.60
15		15.60	8.96	22.35
30	Oniyaya	22.30	11.80	25.00
45		31.90	16.00	32.00
60		32.00	16.90	30.50
0		11.10	6.20	18.00
15		15.50	7.32	21.75
30	Amugbadu	20.30	9.50	23.60
45		26.40	14.20	25.50
60		26.50	14.50	23.65
LSD (0.05)				
Nitrogen (N)		0.97	0.42	0.72
Variety (V)		0.61	0.27	0.45
N x V		0.59	0.11	0.32

The phosphorus, variety and phosphorus by variety interactions ($P \le 0.05$) significantly influenced the plant height and number of leaves of corchorus (Table 4). The highest plant height and number of leaves were obtained at the optimum rate of 30 kg P_2O_5 ha^{-1}. This optimum P rate, for plant height and number of leaves falls within the range recommended by Ojo and Olufolaji (1997), for amaranth. Fagbayide (1997) also observed significant increased in height of pepper as P rates increased. The simple and interaction effects of phosphorus and variety on corchorus fresh shoot, dry matter yields and number of branches are shown in Table 5. The measured variables were significantly ($P \le 0.05$) affected by the treatments, with maximum values obtained at 30kg ha^{-1} of applied P. This optimum P rate was closed to the 34 kg P_2O_s recommended for corchorus and other leafy vegetables by Ojo and Olufolaji (1997). P fertilization influenced plant growth because of low soil P which required an input of P for optimum plant growth especially for rapid growing of annual crop such as corchorus (Zapata and Axman, 1995).

In both N and P fertilizer treatments, Oniyaya variety gave the highest values of all the growth parameters measured than Amugbadu corchorus variety. This agreed with the work of Epenhuijsen (1974) who reported that Amugbadu is less productive.

Table 4: Effect of different levels of Phosphorus fertilizer on the average plant height and number of leaves of *Corchorus olitorius* varieties.

		Plant Height (cm)				Number of Leaves			
	Week after sowing								
P level (kg ha^{-1})	Variety	2	4	6	8	2	4	6	8
0		4.44	9.43	17.12	18.57	5.00	9.00	13.25	11.25
10		5.12	11.75	20.12	28.62	5.83	10.02	13.65	19.50
20	Oniyaya	5.46	11.78	22.12	30.25	5.50	11.62	15.12	23.62
30		5.79	13.48	24.35	33.37	5.70	13.87	16.50	23.65
40		5.31	13.57	21.75	32.06	4.91	10.25	15.62	21.13
0		3.63	7.75	11.50	15.87	4.65	7.00	12.00	10.50
10		4.63	9.50	15.00	21.50	5.50	8.25	12.52	18.50
20	Amugbadu	4.63	10.75	16.00	25.25	5.50	9.26	14.00	20.00
30		5.13	11.50	21.50	26.50	5.75	11.50	15.20	21.50
40		5.00	11.80	22.00	27.00	5.76	10.85	13.00	19.00
LSD (0.05)									
Phosphorus (P)		0.09	0.19	0.51	0.25	0.22	0.13	0.52	0.74
Variety (V)		0.05	0.12	0.33	0.16	ns	0.08	0.33	0.47
P x V		0.01	0.02	0.17	0.04	0.22	0.01	0.17	035

Table 5: Mean fresh shoot, dry matter yields and number of branches of *Corchorus olitorius* varieties as influenced by P applications.

P level (kg ha^{-1})	Variety	Fresh Shoot yield (g)	Dry Matter yield (g)	Number of Branches
0		14.00	3.50	18.70
10		20.40	12.00	23.25
20	Oniyaya	24.00	13.25	25.75
30		25.85	15.50	28.10
40		19.30	8.75	26.00
0		12.50	6.56	17.50
10		15.20	7.25	18.00
20	Amugbadu	17.55	8.50	19.75
30		21.25	11.05	22.50
40		20.00	9.36	19.00
LSD (0.05)				
Phosphorus (P)		0.93	0.45	0.96
Variety (V)		0.59	0.28	0.61
P x V		0.55	0.13	0.59

Yield and yield components

The number of flowers, weight of 100 seeds, capsule and seed yields significantly ($P \leq 0.05$) affected by the nitrogen, variety, and the nitrogen by variety interaction (Table 6). Flower production of corchorus plants on plots receiving nitrogen treatments were delayed for 7 days compared with the control (data not shown). This might be due to the influence of nitrogen on the promotion of vegetative development at the expense of reproductive development as earlier reported by Tisdale and Nelson (1990). All the yield and yield attributes measured increases up to optimum rate at 45 kg N ha^{-1}, and then declined thereafter. This is in agreement with Brantley and Warren (1960) who observed a significant increased in the number of flowers as N level increased. The reduction in yields of plants treated with the highest levels of nitrogen could be attributed to luxury consumption by the plant, which favours excessive vegetative growth (Sobulo *et al.,* 1977; Locasco *et al.,* 1984).

Table 6: Effect of N application on the yields and yield components of *corchorus olitorius* varieties.

N level (kgha^{-1})	Variety	Number of Flower	Weight of 100 seeds (g)	Capsule yield per plant (g)	Seed yield per hectare (kg ha^{-1})
0	Oniyaya	15.00	0.217	1.80	182.50
10		16.00	0.219	1.90	210.00
20		17.25	0.220	2.13	215.00
30		18.00	0.223	2.50	262.00
40		16.00	0.216	2.22	220.00
0		14.00	0.219	1.37	105.00
10	Amugbadu	15.00	0.220	1.50	157.00
20		16.00	0.217	1.57	215.00
30		17.50	0.220	1.90	237.50
40		15.00	0.212	1.53	187.50
LSD (0.05)					
Nitrogen (N)		0.92	0.10	0.10	0.01
Variety (V)		0.58	0.06	0.06	0.01
N x V		ns	0.01	0.01	0.0001

Number of flowers, weight of 100 seeds, capsule and seeds yields were all improved significantly by application of P with the maximum values obtained at 30 kg P_2O_s ha^{-1} (Tables 7). The phosphorus by variety interactive effects were also significant except for the number of flowers. The positive seed yield and yield components response of *corchorus olitorius* to applied P was in agreement with the report of Ojo and Olufolaji (1997), who observed that the application of P significantly increased grain yield of amaranthus. The effect of P was related to increase in flower and number of fruits or capsules rather than in their weight and it is therefore likely that too late an application of this nutrient could leads to serious losses of yield if soil is very deficient.

Table 7: Effect of P application on the yields and yield components of *corchorus olitorius* varieties.

P level ($kgha^{-1}$)	Variety	Number of Flower	Weight of 100 seeds (g)	Capsule yield per plant (g)	Seed yield per hectare (kg ha^{-1})
0		15.00	0.210	1.81	162.50
10		19.00	0.218	2.12	202.00
20	Oniyaya	19.50	0.219	2.74	227.50
30		21.00	0.220	2.86	292.50
40		20.00	0.218	2.80	267.50
0		15.00	0.200	1.40	165.00
10	Amugbadu	17.00	0.212	1.54	205.00
20		18.00	0.215	1.80	212.50
30		19.00	0.220	1.97	220.00
40		19.00	0.218	1.78	212.50
LSD (0.05)					
Phosphorus (P)		0.76	0.001	0.06	0.01
Variety (V)		0.48	0.001	0.04	0.01
P x V		ns	0.000001	0.002	0.001

Conclusion

In conclusion, there were significant increased in all measured variables, as shown above the control with sole application of each of N and P suggesting that the experimental soils required additional application of the elements for increased corchorus production. The response to each fertilizer treatments varied slightly but significantly among the different varieties used. However, in terms of effects of sole application of each of N and P on growth, yield and yield components of corchorus, the choice of 45 kg N and 30 kg P_2O_5 ha^{-1} respectively, were of larger increases in the rate of applying nutrient.

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