Niger Agric. J. 30 (1999): 49 -58

EFFECT OF DENSITY AND FERTILIZATION ON THE PERFORMANCE OF MELON (Citrullus lanatus Thunb)

V. B. OKAKA AND S.U. REMISON

Faculty of Agriculture
Edo State University
Ekpoma, Nigeria
(Accepted November 1998)

ABSTRACT

Experiments were carried out to determine the effects of population density and fertilizer application on melon during the planting seasons of 1990 and 1991 at Ekpoma, a forest/derived savanna zone in the northern part of Edo State. In 1990, a local variety of melon was sown at six different spacing of 120 x 120cm, 120 x 90cm, 90 x 90cm, 120 x 60cm, 90 x 60cm and 60 x 60cm giving equivalent plant population densities of 7,000, 9,000, 12,000, 14,000, 19,000 and 28,000 plants ha^{-1} respectively. The yield and yield components of melon increased at lower population densities while at higher population densities beyond 19,000 plants ha^{-1} they were reduced .The highest seed yield was obtained at 14,000 plants ha-1 mainly because of increased number of pods.

In 1991, melon was planted at the optimum spacing of 120 x 60cm and five rates of NPK fertilizer; 0, 50, 100, 150 and 200kg ha^{-1} were imposed. Fertilization increased pod number and seed yield; the highest yield was obtained when 200kg ha^{-1} of fertilizer was applied.

INTRODUCTION

The spatial distribution of plants in a crop community is an important determinant of yield. According to Webster and Wilson (1980), the optimum plant density and spacing naturally vary with crop species and to a lesser extent with soil, climate and economic factors. Optimum density is also determined by water availability and carrying capacity of the land (Oladokun et al., 1987). As the distance between plant stands is reduced, with resultant increase in population density, plants show evidence of increased competition for growth factors (Oadokun, 1978).

In melon cultivation, emphasis is usually on the density that will rapidly cover the soil for effective weed control and live mulch (Usorch, 1979; Wahua, 1985; Olasantan, 1988) and not on the spatial arrangement of crop stands in and between rows. The rapid growth and creeping habit of melon are desirable qualities frequently harnessed in the traditional and improved mixed cropping systems in the tropics (Fagbamiye, 1977; Phillips, 1977). A clear cut yield response of melon to density is yet to be established since yield obtained by Phillips (1977) using 40,000 plants ha^{-1} was comparable to that where 2,500 plants ha^{-1} were used (ANON, 1992); as 425kg ha^{-1} and 300 - 400kg ha^{-1} dry seeds were obtained respectively.

Melon generally requires well drained, moderately fertile soils (Hill, 1952; Irvine, 1969; Phillips, 1977) at the traditional level, the crop is sown on well cleared and burnt soil without fertilization. There is a general assumption that the burning of cleared debris enriches the soil of phosphate and exchangeable cations (Nye and Greenland, 1960) and increases the microbial population with attendant improvement in the rate of mineralization (Corbett, 1934).

Though the mineral requirement of melon is low, the crop has been shown to respond favourably to fertilizer application (Adeniran, 1984). At NIHORT, Ibadan, the following fertilizer recommendation has been made for melon: 200kg ha^{-1} of NPK 15:15:15 compound fertilizer or 50kg N ha^{-1}, 30kg P_2O_5 ha^{-1} and 30kg k_20 ha^{-1} as basal application, two days before sowing the seeds, to boost vegetative growth. There should also be a side dressing of 100kg ha^{-1} of sulphate of ammonia applied 15cm away from the plant stand at flowering for enhanced reproductive growth (ANON, 1982). Artificial fertilization has not been of prime consideration in melon cultivation. In studies involving melon and other crops, melon may not be specifically supplied with fertilizer other than what it benefits from the supply to its companion crop as demonstrated by Olasantan (1988).

There is a dearth of knowledge on the optimum planting density and fertilizer requirement of melon. In order to increase melon production, research efforts are necessary in many areas. This study was therefore embarked upon to resolve some of the agronomic problems of melon production with the main objectives of determining the optimum population density and the effects of fertilizer application.

MATERIALS AND METHODS

The experiments were conducted at the Teaching and Research Farm of the Edo State University, Ekpoma during the planting seasons of 1990 and 1991. This location (Lat. $6^0 42'$ North and Long. $6^0 8'$ East) which is in Edo North of Nigeria is a forest/derived Savannah Zone characterised by a bimodal rainfall pattern often with a break in August. It has an altitude of 460m above sea level and experiences an annual rainfall of about 1,556mm. The soil used was rich in organic matter and had been left fallow for two and three years prior to cropping in 1990 and 1991 respectively. The site was previously cropped to cassava.

The melon used was a local variety commonly grown in mixture with other crops in the area. The first experiment in 1990 was a population density experiment. Six different plant spacings used were 120cm x 120cm, 120cm x 90cm, 90cm x 90cm, 120cm x 60cm, 90cm x 60cm and 60cm x 60cm which gaveequivalentplant populationsof 7,000,9,000,12,000,14,000,19,000 and28,000 plants ha^{-1} respectively. The design was a randomised complete block with three replicates. The experimental area of eighteen plots measured 54.7m x 9.2m with 1.5m and 2.0m within and between replicate plots respectively. The experiment was sown on the flat on 10 April, 1990. Two seeds were sown per stand and later thinned to one plant per stand after two weeks All plots were sprayed with Gammalin 20 at 2 weeks after planting to reduce foliar pests. There were two hoe weedings at 3 and 5 weeks after planting.

Record was taken on number of days to 50% flowering, 50% podding, flowering to podding intervals, number and weight of pods per plant, pod diameter, seed yield and seed: pod ratio.

The second experiment was sown in 21 March, 1991 at a uniform spacing of 120 x 60cm, which gave an equivalent plant population of 14,000 plants ha^{-1} in all plots. The choice of this population density was based on results of the first experiment which showed that this population was the optimum. Each plot size measured 6.5m x 8m. Five NPK fertilizer rates were imposed at 0, 50, 100, 150 and 200 kg ha^{-1} and designated F_0, F_1, F_2, F_3, and F_4 respectively. The experiment was laid out in a randomized complete block design with four replicates.

Chemical composition of soil used before cropping is shown in Table 1. After the first weeding at 2 weeks after planting, each fertilizer treatment was applied between crop stands in rows. A second weeding was carried out at 6 weeks after planting. The population of foliar insects was reduced by spraying with Gamalin 20 at about 3 weeks after planting.

Data collected were similar to those of the first experiment and analysis of variance carried out.

Table 1: Chemical Composition of Soil used before cropping in 1991

PH (Suspension 1:2.5 in water	5.70
Cation Exchange Capacity (cmol/kg)	6.28
Organic Carbon (%)	2.08
Total Nitrogen (%)	0.11
C/N ratio	18.9
Available P (ppm)	9.08
Exchangeable K (cmol/kg)	0.22
Exchangeable Na (cmol/kg)	0.10
Exchangeable Ca (cmol/kg)	5.16
Exchangeable mg (cmol/kg)	0.44

RESULTS AND DISCUSSION

The results of the experiment on population density are presented in Tables 1 and 2. Flowering and podding commenced about 4 and [illegible] weeks after planting respectively and were not significantly affected by varying the population density of melon from 7,000 to 28,000 plants ha-1. The mean number of days from flowering to podding was 15 days (Table 2).

Pod diameter, number of pods per plot and seed: pod ratio were not significantly affected by population density whereas pod weight, number of pods per 100 plants and seed yield were significantly affected (Table 3). Number of pods per plot seemed to increase linearly with increase in population density except at 12,000 plants ha^{-1}. Number of pods per 100 plants was highly significant ($P \leq 0.01$). Generally, the number decreased with increase in density; the highest number of 230 pods was obtained at the lowest population of 7,000 plants ha^{-1} . Similarly, pod weight was highly significant (P/ 0.001) and generally decreased with increase in population density. Pod weight at the lowest population density at 7,000 plants ha^{-1} was greater than that of the highest density (i.e. 28,000 plants ha^{-1}) by 20%. Density also had significant effect (P / 0.05) on seed yield though there was no particular pattern. The spacing of 120cm x 60cm gave the highest overall yield which was 81% higher than the lowest yield from the spacing of 90cm x 90cm. The seed: pod ratio was very low indeed.

Table 2: Effects of population density on days to flowering and podding of melon

Spacing (cm)	Population density (plants ha^{-1})	50% flowering	50% podding	Flowering to podding interval
120 x 120	7,000	32.3	48.0	15.7
120 x 90	9,000	32.7	44.7	12.7
90 x 90	12,000	30.7	49.0	18.3
120 x 60	14,000	31.0	45.0	14.0
90 x 60	19,000	32.0	46.7	14.7
60 x 60	28,000	31.3	46.0	14.7
Mean		31.7	46.6	15.0
S. E.		1.80	3.26	3.37

Density had no significant effect on flowering and podding. This finding trees with the report of Olasantan (1988), that competitive stress from neighbouring plants is not evident in the vegetative characters of melon at 19,000 plants ha^{-1}. The reduction in number of pods per 100 plants and weight of pods as plant density increased from 7,000 to 28,000 plants ha^{-1} is attributable to intra-specific competition. The potentials for pod development of melon were better realised at low population densities of 7,000; 9.000; 12,000 and 14,000 plants ha^{-1} beyond which pod weight decreased drastically. Remison et al., (1980) have indicated that plant size of cowpea is usually larger with sparse density and hence yield and its components per plant are expected to be greater. At 7,000 plants ha^{-1} when potential development of melon was attained, melon produced the highest number of pods per plant which was significantly higher than the mean number pods per plant produced by other population densities as shown in Table 3. From a population density of 7,000 to 19,000 plants ha^{-1}, mean pod number were not significantly different, suggesting an optimum range for pod yield.

In this experiment, the major determinant of seed yield was the number of pods produced per plant and this is in agreement with the result of Olasantan (1988) that reduction in seed yield was mainly due to the reduction in number of fruits per plant. Other important characters that may have influenced seed yield are pod size and weight.

Table 3: Effects of population density on yield and yield components of melon

Spacing (cm)	Population density (plants ha^{-1})	Pod diameter (cm)	Number of pods/plot	Number of pods/100 plants	Weight (kg/pod)	Seed yield (kg ha^{-1})	Seed: Pod ratio
120 x 120	7,000	11.5	83.0	230	0.60	223.12	0.02
120 x 90	9,000	12.3	100.0	170	0.62	270.06	0.03
90 x 90	12,000	10.8	71.7	110	0.52	167.18	0.02
120 x 60	14,000	11.5	108.3	150	0.57	302.21	0.02
90 x 60	19,000	11.3	144.3	150	0.46	270.06	0.03
60 x 60	28,000	11.0	120.7	80	0.44	181.97	0.02
Mean		11.4	104.7	150	0.54	235.76	0.02
S. E.		053	25.07	23.0	0.030	38.130	0.008

At 14,000 plants ha^{-1} there was apparently enough foliage spread for effective ground cover, being an intermediate level between 1m x 1m (10,000 plants ha^{-1}) recommended by Usoroh (1979) and 1m x 0.5m (20,000 plants ha^{-1}) recommended by Wahua (1985). Melon shows an asymptotic response to population density, thus presenting a wide range of population densities from which any one can be selected for specific requirements like weed and erosion control. Optimum yield was however obtained at 120cm x 60cm (14,000 plants ha^{-1}) and hence this population was selected for a subsequent experiment.

The results of the experiment are presented in Table 4 and 5. Fertilizer application had no significant effect on days to flowering and podding. The periods at which 50% flowering and podding were obtained were similar to those in the first experiment.

Table 4: Effects of Fertilizer application on days to flowering and podding

NPK applied (kg ha-1)	50% flowering	50% podding	Flowering to podding Interval
0	33.5	46.8	13.3
50	33.5	47.8	14.3
100	32.5	46.5	14.0
150	33.8	47.5	13.7
200	35.8	47.0	13.3
Mean	33.8	47.1	13.7
S. E.	1.23	0.89	0.57

Table 5: Effects of Fertilizer application on yield and yield components of melon

NPK applied (kg h-1)	Pod diameter (cm)	Number of pods/plot	Number of pods/100 plants	Weight (kg/pod)	Seed yield (kg ha-1)	Seed: Pod ratio
0	10.3	42.3	60	0.65	161.11	0.02
50	10.2	79.5	110	0.71	315.27	0.02
100	9.7	54.3	80	0.54	203.47	0.02
150	9.06	79.5	110	0.58	362.85	0.03
200	11.7	93.3	130	0.74	479.86	0.03
Mean	10.3	69.8	100	0.64	304.51	0.02
S. E.	0.36	22.74	23.0	0.064	84.673	0.003

Fertilizer application had no effects on number of pods, but pod diameter, pod weight and seed yield were significantly affected (Table 5). The number of pods per 100 plants at the highest rate of fertilizer application was 117% greater than the control, where no fertilizer was applied. Similarly application at the highest level increased pod diameter by 14% and there was no pronounced difference between the other fertilizer rates and the control. The weight of individual pods was also increased by 14% with the application of 200kg of fertilizer compared with the control. The affects of the other fertilizer rates were inconsistent. The most pronounced effect of fertilizer application was on seed yield.

Even the lowest level of 50kg ha-1 increased seed yield by 96% over the control. At 200kg ha-1, yield was increased by about 198%. As recorded in the first experiment, the seed: pod ratio were very low but they were significantly higher at the higher fertilizer levels.

The results of this experiment show that melon generally responds to NPK fertilizer especially at high rate of application. This is in agreement with the recommendation by NIHORT (ANON, 1982) of a minimum application of 200kg NPK (15:15:15) ha^{-1} or 50kg N ha^{-1}, 30kg P_2O_5 ha^{-1} and 30kg K_2O ha^{-1}. At the traditional level, melon is not supplied with fertilizer after sowing on cleared and burnt land. It is usually the first crop planted at the beginning of the season before other crops like yam, cassava or maize are introduced. It thus had a chance in the cropping sequence of taking advantage of the flush in nutrients with early rains following the long dry season. It however benefits from fertilizer applied by some farmers to crops grown in association with it.

Days to flowering and podding were apparently unaffected by NPK fertilizer. In many annual plants, fertilizers have a tendency of increasing vegetative growth and may therefore not have direct influence on flowering and fruiting. There was evidence in this study that fertlization slightly prolonged vegetative growth.

Pod size, seed yield and seed: pod ratio were significantly increased by NPK fertilization, indicating a positive response of melon to fertilization. The low seed: pod ratio was indicative of the fact that most parts of melon fruit is made up of pulp. This ratio was however, slightly increased at high levels of fertilizer application. The large effects of NPK on yield and yield components even at the lowest level of 50kg ha^{-1} shows clearly that farmers' yield are far below the potential yield of the crop.

Thus varying melon population from 7,000 to 19,000 will optimize yield. At any population density within this range, and with adequate management, the performance of melon will be satisfactory. However, a spacing of 120 x 60cm, which gives a plant population density of 14,000 plants ha^{-1}, gave the highest yield in this study and is recommended.

It is possible to increase the yield of melon a great deal by applying fertilizer to the crop in the field. Even in newly opened up farms, melon seed yield can be substantially increased in sole and mixed cultures by applying about 200kg ha^{-1} of NPK fertilizer early enough.

ACKNOWLEDGEMENT

This study formed part of M. Sc. Thesis submitted to the Department of Agronomy, Edo State University. I am grateful to the Dean, the Head of Department and the entire farm staff for technical assistance.

REFERENCES

Adeniran, M. O. (1984). Highlights on egusi melon (Citrullus lanatus) improvement in Nigeria. NIHOT Occassional Paper No. 16 National Institute for Horticultural Research, Ibadan - Nigeria.

Anon (1982). Guide to the production of egusi melon. NIHORT'S CREST (Extension Guide) No. 6 Extension and Research Liaison and Training. National Institute for Horticultural Research, Ibadan - Nigeria.

Corbett, A, S, (1934). Studies in Tropical Soil Microbiology II. The bacterial numbers in the soil of the Malay Peninaula. Soil Science, 38: 407-416.

Fagbamiye, A. (1977). Investigations of traditional mixed cropping and intercropping systems in the topics. Ph. D. Thesis, Agronomy Department, University of Ibadan, Ibadan - Nigeria.

Haizel, K. A. and E. K. Ahiekpor, (1975). A comparison of the effect of plant density and pattern of spacing on growth, development and yield of two cultivars of maize: Mexican 17 and Composite II. Ghana Journal of Agricultural Science, 8; 99-108.

Hill, F. A. (1952). Economic Botany. A Textbook of Useful Plants and Plant Products. Second Edition. McGraw-Hill Book Company, New York.

Irvine, F. R. (1969). West Africa Crops. Longman, London.

Nye, P. H. and D. J. Greenland, (1960). The soil under shifting cultication. Comm. Bur: Soils, TCch. Commun. No. 51.

Oladokun, M. A. O. (1978). Nigeria weed species - Intraspecific competition. Weed Science. 26: 713 -718.

Oladukun, M. A. O., M. A. O. Okelana, and E. B. Esan, (1987). Effects of population density on growth and yield of four tea (Camelia sinensis L.) clones on Mambilla Plateau. Nigeria Journal of Agronomy, 2: 1- 4.

Olasantan, F. O. (1988). The effects on soil temperature and moisture content and crop growth and yield of intercropping maize with melon (Colocynthis vulgaris) Experiment Agriculture, 24: 67-74.

Phillips, T. A. (1977). Agricultural Notebook, Longman, London. 312p.

Remison, S. U., B. Bello, and T. Okunariwo, (1980). The effects of different spacings and phosphorus application on growth and yield of cowpea (Vigna unguiculata (K.) (Walp). Ife Journal of Agriculture 1: 62-73.

Usoroh, N.J. (1979). Assessment of the efficiency of melon (Colocynthis citrullus) as the live mulch for weed control in Okra (Abelmoschus esculentus). Paper presented at the 2nd Annual Conference of the Horticultural Society of Nigeria, 6-9th November, Enugu, Anambra State, Nigeria.

Wahua, T. A. T. (1985). Effects of melon (Colocynthis vulgaris) population density on intercropped maize (Zea mays) and melon. Experimental Agriculture, 21: 281 - 289.

Webster, C. C. and P. N. Wilson, (1980). Agriculture in the Tropics. Second Edition. Longman Group Limited, 1966, 1980, New York, 640 p.