The effect of Plant Population on sunflower [Helianthus annus L.] seed yield in southwestern Nigeria

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Abstract

Field experiments were conducted at two locations during the early and late seasons of 1966 to 1968 to investigate effects of plant population on seed yields of sunflower, variety Russian Giant. Plant population treatments significantly influenced seed yields and yield components. Mean yields differed significantly between early and late seasons and highest yields of 2,822kg/ha and 1,238kg/ha were obtained at 18,000 plants/ha indicated as the optimum population. Significant population x location and location x season interactions were observed. High humidity in the rainforest zone resulted in severe head rot and low yields. It is suggested that sunflower varieties might differ in seed production efficiency.

Introduction

The secular decline in the production of oil palm and groundnut - the two main local sources - in Nigeria has created problems in meeting the requirements and demands for vegetable oils. In an effort to meet the increasing demand for vegetable oils and reduce Nigerian imports of groundnut, the need arose to identify potential substitutes and other sources of vegetable oils. Investigations through field studies on arable oilseeds started in 1965 but had to be temporarily suspended in 1968 for lack of facilitieis. During that period, the possibility of large scale cultivation of sunflower was investigated at the Institute of Agricultural Research and Training, Moor Plantation, Ibadan. Ogunremi (1978) reported results of sunflower varietal performance testings for adaptability. This paper reports three seasons' experiments on the yield response of sunflower to plant population. The objective was to determine an optimum plant population for large scale production of sunflower under the climatic conditions of southern Nigeria.

Materials and methods

The experiment was conducted at Ilora (7°45N, 3°52½'E) in the derived savanna zone and Ikenne (6°52'N, 3°42'E) in the rainforest area during the early and late seasons of 1966 to 1968. The soil at Ilora was mostly of colluvial material derived from the basement complex. Classified as ferric luvisol (FAO system), the soil is sandy down to 50cm being light to dark brown in colour. The mean annual rainfall, distributed over seven months with a short dry spell in August, is approximately 1000mm.

At Ikenne, the soil type was a gleyic luvisol of the Iju series (Moss, 1967); greyish brown in colour with a sandy topsoil and mottled clay in the subsoil. The mean annual rainfall is about 1,400mm distributed over eight months with dry spell in August.

The sunflower variety 'Russian Giant', introduced from Russia, was used for the trial. The treatments consisted of five population densities - 12,000, 14,000, 18,000, 24,000, and 36,000 plants per hectare. The design was a randomised complete block with six replications. Each plot was 11 by 11m (gross) and 9 by 9m (net). The population treatments were achieved by using intra-row spacings of 90cm, 76cm, 60cm, 45cm and 30cm. Planting was done on 0.9m ridges at the rate of 2 to 4 seeds per hole at a depth of about 4cm. Early season plantings were done during the first week of April and the late season plantings in the second week of September each year. About ten days after planting, blanket dressings of fertilizers were applied in shallow trenches on either top side of each ridge at the rate of 45kg N/ha (as sulphate of ammonia), 56 kg P/ha (as single superphosphate) and 100kg k/ha (as muriate of potash). Thinning was done to one plant per hole. Weeding was done as necessary and bird scaring was done to protect the plants after 'spearing'. Average plant height was recorded immediately after spearing; at harvest, the total number and weight of heads were recorded for each treatment. Threshing was done by hand to recover the seeds which were later sundried. Random samples were taken from which average weight/head, seed/head, weight/100 seeds were recorded after drying to constant weight. The data collected on plot basis for each location were later subjected to statistical analysis. A combined analysis for both locations was also done.

Results

The data from the trials which showed similar patterns throughout are presented as three year means in Tables 1 and 2. Germination, which was not influenced by population density, took 6 and 14 days respectively for the early and late plantings. Physiological maturity was earlier by five days in the savanna (Ilora) than in the rainforest (Ikenne) zone; days to harvest being 107 and 112 respectively. The sunflower characteristic known as 'Nutation' (Robinson et al., 1967) was observed at both locations. The heads and the leaves faced east at sunrise, being erect at noon.

Seed yield and its components:

Except during the early season at Ikenne, there were significant effects of plant population on seed yield (Table 1). The influence of population on seed yield was offset at Ikenne by serious incidence of diseases and pests. Seed yields increased with plant population up to 18,000 plants per hectare beyond which further increase in population depressed seed yield. Number of heads produced, weight/head, seed/head and weight/100 seeds, (seed size) were significantly influenced by variations in plant population (Table 2). Plant height was not affected.

The effect of season and location:

Yields were extremely low at Ikenne in the rainforest zone in both seasons averaging 100 and 435 kg/ha for early and late seasons respect-

ively. (Table 1). At Ilora in the savanna belt, yields compared favourably with those recorded in other sunflower producing countries (Kinman, 1963; Kinman and Earle, 1964; Putt, 1967), averaging 2,290 and 1,009 kg/ha for early and late seasons respectively. The seasonal differences in seed yield could mainly be attributed to differences in the number of heads produced per unit area and such yield components as seed/head and seed size. Weight/head, seed/head and weight/100 seeds were significantly increased with reduction in population from 36,000 to 18,000 plants/hectare which was the optimum population under the conditions of this study (Table 2). Significant interactions between location and season, location and population were observed but the population x season interaction was not significant.

TABLE 1. THE EFFECT OF PLANT POPULATION ON SEED YIELD (KG/HA)

Location	Plant population/ha					L.S.D at 5%
	12,000	14,000	18,000	24,000	36,000	
Ilora (E	2,055.5	2,560.8	2,811.1	2,195.1	1,831.1	275.3
Ilora (L	905.5	1,128.1	1,238.4	967.0	806.7	121.3
Ikenne (E	100.8	115.5	102.5	87.7	94.0	N.S.
Ikenne (L	316.8	564.4	528.3	419.3	348.0	60.4

E = Early Season; L = Late season.

Seed production efficiency:

The ratio of seed weight/head: weight/head expressed as a percentage was calculated and designated 'S ' in this work. This was used as a measure of the crop's efficiency in producing seeds. There were no indications of any effect of population density on seed production efficiency. There were, however, indications of effects of season and location on seed production efficiency (Table 2). At Ilora, seed production was found to be more efficient in the early (41 percent) than in the late 32 percent) season. Sunflower seed production efficiency was low (20 percent) during the early season in the rainforest zone. (Table 2).

TABLE 2. THE EFFECT OF PLANT POPULATION ON YIELD PARAMETERS

	Location		Plant population 12,000	14,000	18,000	24,000	36,000	L.S.D at 5%
	Ilora	(E	25.7	26.8	30.4	40.8	54.3	9.2
		(L	17.1	17.9	20.2	27.2	36.2	7.3
Heads/ha.	Ikenne	(E	8.5	8.5	10.7	12.4	12.4	2.1
('000)		(L	11.3	13.3	16.6	19.8	25.2	1.5
	Ilora	(E	225.5	212.1	200.0	161.3	85.8	52.4
		(L	158.8	151.9	143.1	115.2	53.5	38.9
Wt/head (g.)	Ikenne	(E	49.5	53.9	51.9	43.5	40.2	N.S.
		(L	108.1	86.7	70.8	55.6	34.7	10.6
	Ilora	(E	72.9	82.9	94.2	68.0	39.2	12.2
		(L	47.0	51.7	48.9	45.0	43.5	N.S.
Seed/head	Ikenne	(E	11.1	10.4	9.7	9.3	8.2	N.S.
(g.)		(L	30.8	31.6	32.6	28.6	12.9	4.4
Wt/100(g.)	Ilora	(E	246.9	250.1	254.0	254.0	210.4	26.3
		(L	207.7	208.4	211.6	211.6	175.1	21.9
	Ilora	(E	2.26	2.69	2.83	2.75	2.68	N.S.
		(L	2.46	2.50	2.68	2.59	2.50	N.S.
Plant height	Ikenne	(L	2.19	2.12	2.09	2.16	2.04	N.S.
(m.)		(L	1.67	1.78	1.77	1.75	1.72	N.S.
	Ilora	(E	31.3	39.1	47.1	42.1	45.7	
		(L	29.6	34.0	34.2	39.1	52.1	
Seed: Head	Ikenne	(E	22.4	19.2	18.6	21.3	20.5	
(%) 'S '		(L	28.5	36.5	46.1	51.4	37.2	

N.S. = Not Significant

Discussion

The poor performance of sunflower in the rainforest zone confirms previous recommendations (Ogunremi, 1978) that sunflower cultivation in southern Nigeria should be restricted to the derived savanna areas. The low yield could be attributed to the severe head rot under conditions of high humidity prevalent in that area. The results agree with those reported by Hoes (1969) who observed similar severe head rot in Canada under prolonged wet weather and cool temperature conditions in summer.

The seasonal differences in yields observed at Ilora were partly due to differences, though not significant, in the percentage establishment. There were indications that more heads 'dried up' after the 'spearing' stage. This also accounted for the lower number of heads produced in

the late than in the early season. Besides, sunflower produced smaller-sized heads with less seed weight and lighter seeds in the late than in the early season (Table 2). For these reasons it is recommended that for maximum seed yields, sunflower should be cultivated in the savanna belt only during the early season.

The significant influence of plant population on seed yields was at variance with Putt (1967) who reported that in tests over three years, narrow spacings yielded as well as wider spacings and recommended 54,000 plants/ha as the optimum population. For the variety, Russian Giant used in this work, 18,000 plants/ha appeared optimum (Table 1). It is not unlikely that varieties differ in their responses to variation in plant population. It must be noted that the significant interaction between population and location is an indication that optimum plant population would vary with location also.

That head size, seed/head and weight/100 seeds (seed size) increased with increasing plant population until the optimum was reached is an indication that distance between plants could be an important factor determining sizes of these yield components. Although greater numbers of heads were produced at higher densities of 36,000, 24,000 than at 18,000, the differences were not large enough to offset the compensatory effects of increases in other yield components such as head size, seed weight/head and seed size (Table 2). Table 2 clearly shows that weight/head decreased as plant population increased while number of heads increased with population. Detailed growth analysis studies will be required for more accurate and better interpretation of plant population effects particularly in terms of dry matter distribution among the yield components.

That Russian Giant was more efficient in seed production in the early than in the late season at Ilora is an indication that varieties might be different in seed production efficiency with possible location x season interaction effects on this attribute, 'S '. In previous studies on sunflower varietal performances at different spacings in which Russian Giant was not included (Ogunremi, 1978), it had been found that the crop was more than twice as efficient when grown in the late as in the early season at Ilora. The reverse was observed from Russian Giant in this work at the same location. This aspect will receive more attention in future studies.

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