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GROWTH AND YIELD RESPONSE OF SESAME (*Sesamum indicum* L.) TO FOLIAR AND SOIL APPLIED FERTILIZER IN MAKURDI, BENUE STATE

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ABSTRACT

The use of different forms of chemical fertilizer and organic fertilizer has its advantages and disadvantages in the context of nutrient supply, crop growth and environmental quality. The experiment was conducted during the 2011 cropping season at the Teaching and Research Farm of the University of Agriculture, Makurdi to assess the response of sesame (S*esamum indicum* L.) to foliar and soil applied fertilizers. The experimental design was split plot (2x4) laid out in Randomized Complete Block Design (RCBD) and replicated three times. Before the commencement of the experiments, soil samples were collected for analysis. Treatments combinations were made up of two sesame varieties (E8 and SN603) as main plots while NPK 15:15:15, compost plus, foliar and control as sub-plots. Data collected include; days to 50% flowering, numbers of seeds per capsule, 1000 seed weight (g), seed yield (t/ha), etc. Data were analyzed using Genstat Release 7.2 DE (LAT. 2007). Result of the soil analysis showed that, nutrient status of the soil was low for sesame production. The result of seed yield (kg/ha) showed significant difference among the fertilizer types. The highest seed yield was obtained from inorganic fertilizer (359.0kg/ha) followed by organic compost plus (252.0kg/ha) and the least was from foliar fertilizer (194.0kg/ha). At interactions, seed yield (kg/ha) showed significant difference. The highest seed yield was obtained from E8 and inorganic fertilizer at interaction (396/kg/ha). Therefore, application of E8 and NPK 15:15:15 in combination is highly recommended for high yield of sesame seeds.

Keywords: **growth, yield, sesame, foliar, soil, fertilizer**

INTRODUCTION

Sesame (*Sesamum indicum L.*) belongs to the plant family *Pedaliacea* commonly called beniseed in Nigeria. It is an important oilseed crop believed to have originated from tropical Africa, where you have the greatest genetic diversity. It was later taken at a very early date to India where a secondary centre of diversity developed (Purseglove, 1969). Oplinger *et al.* (1990) indicated it to be highly prized oilseed crop in Babylon and Assyria about 4,000 years ago. Today India & China are the world's biggest producers of sesame followed by Myanmar, Sudan, Uganda, Nigeria, Pakistan, Tanzania, Ethiopia, Guatemala and Turkey (Burden, 2005). Sesame is cultivated in Nigeria in the derived, Northern and southern guinea, Sudan and Sahel savanna zones. The major states for sesame production in Nigeria are: Adamawa, FCT Abuja, Benue, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Kogi, Nasarawa, Plateau, Taraba and Yobe (RMRDC Survey, 2004). For many years, sesame yields in Nigeria remained very low due to non practice of fertilization by the traditional sesame growers.

Sesame is an important crop to Nigerian agriculture, it is quite extensively cultivated, it yields in relatively poor climatic conditions, and widely used within Nigeria and is an important component of Nigeria's agricultural exports. As a small holder crop, often intercropped with others, the extent of cultivation is poorly known and there is little information on yields or productivity. For the most part the surplus crop is commercialized bulked up and exported with minimal processing limited to drying and cleaning (RMRDC Survey, 2004).

There are several uses of sesame but the most important of all is for edible purpose. Sesame seed (approximately 50% oil and 25% protein) are used in baking, candy making and other food industries, the whole food are use in a bakery trade on bread and rolls as deco rants in many part of the world. They are use in confections, sweetmeat and bird feed. Sesame seeds are used in preparing soups which can be done using different ways and methods as it's varies from different languages. The seeds can be eaten raw or fried, pounded and mixed with sorghum and millet to form a pastry or fried and grained to mix with water to give a sustaining drink (called Mumu in Tiv) (Van Rheenen, 1973). Nitrogen is the most important essential nutrient in plant nutrition. It is a constituent of a large number of necessary organic compounds such as amino acids,proteins, coenzymes, nucleic acids, ribosomes, chlorophyll, cytochrome and some vitamins Marschner (1986) and Noorka *et al*.(2009). Several investigators reported the

positive effects of applying nitrogen fertilization on growth, yield attributes, seed yield and quality of sesame:

For optimum plant growth, nutrients must be available in sufficient and balanced quantities. Soils contain natural reserves of plant nutrients, but these reserves are largely in forms unavailable to plants, and only a minor portion is released each year through biological activity or chemical processes. This release is too slow to compensate for the removal of nutrients by agricultural production and to meet crop requirements. Therefore, fertilizers are designed to supplement the nutrients already present in the soil. The use of different forms of chemical fertilizer and organic fertilizer has its advantages and disadvantages in the context of nutrient supply, crop growth and environmental quality (Young *et al.,* 2004). Therefore, considering the 1.0 ton/ha to 1.2 tons /ha yield potential and the average yield still obtained (0.20 - 0.30 ton ha-1) the objective of this study is to determine the effect of organic compost, inorganic fertilizers and organic foliar fertilizer applications on the growth and yield of sesame in Makurdi; Nigeria .

MATERAILS AND METHOD

The experiment was conducted during the 2011 cropping season at the Teaching and Research farm of the University of Agriculture, Makurdi (Latitude 7.41^0N & Longitude 8.37^0E at an elevation of 97m above sea level). This location falls within the Southern Guinea Savannah Agro-ecological zone of Nigeria. The land was manually cleared after which ridges were demarcated in 4 rows x 5m long and spaced 0.75cm apart using the West African hoe. The experimental design was split plot (2x4) laid in Randomized Complete block design (RCBD) and replicated three times. The treatment combinations in the experiment were allotted at random to plot within each replication. Treatments were made up of two sesame varieties (E8 and SN603) as main plots and three fertilizer types and control as sub-plot. The treatment combinations were as follows: E8 X inorganic fertilizer, E8 X compost plus, E8 X foliar fertilizer, E8X control, SN603 X inorganic fertilizer, SN603 X compost plus, SN603 X foliar fertilizer and SN603 X control. Sesame seeds used in the study were obtained from University of Agriculture, Makurdi Teaching and Research Farm. All the varieties were planted in August 17, 2011. Planting was done by drilling

method and thinned two weeks after planting (WAP) to give within row spacing of one stand per 0.1m which gives a plant population of 133.333 stands/ha.

Two hoe weeding were done to control weeds at 3 and 6 weeks after planting (WAP) The following fertilizers were applied inorganic (NPK 15:15:15) at the rate of 30kg N/ha, 30kg P_2O_5/ha and 30kg K_2O/ha which was two bags per hectare, organic compost plus at the rate of 2t/ha, and NPK foliar at the rate of 3L/ha.The crop was harvested from the field when about 80-90% of the capsule turned yellow. The crop was harvested at 13WAP and 14 WAP for SN-603 and E-8 respectively. Sickle was used for the harvesting of the crop to avoid contamination with the sand. Threshing was done a week after harvesting using a clean tarpaulin for both drying and threshing to avoid contamination.

Before the commencement of experiments, soil augar was used to take surface soil sample from each of the plots and bulked for analysis. Samples were air-dried and thoroughly mixed and sieved using 2mm mesh sieve. Routine analysis was done as described by Tel (1984). Soil pH in 1:2 soils $CaCl_2$ suspension, total N by Kjeldahl approach and available P Bray-P1 extracted followed by molybdenum blue colorimetry. Exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined on flame photometer and Ca and Mg by EDTA Titration soil organic matter will be determined by wet dichromate method.

Five sesame plants from each plot were measured for plant height at flowering and maturity stage using a meter rule from the soil surface to the flag leaf in centimeters. Leaf area was taken from five plants in a plot at flowering and maturing. The leaf area was obtained by carefully tracing the outlines of the leaf on a metric graph paper using the techniques described by Obasi (1989). This procedure involved measuring the length and width of the terminal leaflet of each leaf on the metric graph paper from which their rectangular area were calculated by multiplying with the ratio 0.71 to obtain the correct leaf area.

Days to 50% flowering were determined as the number of days from planting to when 50% of the plants in a particular treatment combination flowered. Five plants were selected randomly for number of primary branches at maturity, number

of leaves per plant at maturity; number of capsules per plant were also counted and recorded per plot combination. Stem diameter at maturity (cm), capsule length (cm), were also measured and recorded from five randomly sampled plants per plot using meter rule. Numbers of seeds per capsule were also taken from five randomly sampled plants per plot using hands to open the capsule and counting the seeds that contained in it. 1000 seed weight (g) was taken using an electric sensitive balance, seed yield (t/ha) were also taken. Seed yields of the varieties were obtained from the experimental plot in kilograms but later converted to tones per hectare. The data collected from the experiment were analyzed using Genstat Release 7.2 DE (LAT. 2007). Means were separated using F-LSD at 5% level of probability.

RESULTS

Table 1 is presented with the result of the soil analysis perior to planting while Table 2 showed the means of the main effects of some fertilizer types on the growth of sesame (*Sesamum indicum L.*) in Makurdi,

2011.

Table 1: Soil physical and chemical properties prior to planting

Physical	
%Sand	77.6
% Silt	13.2
% Clay	9.2
Chemical	
Total N (Kg/ha)	7.33
Ca^{2+} Cmol/kg^{-1}	3.20
Mg^{2+} Cmol/kg^{-1}	1.96
Na^{+} Cmol/kg^{-1}	0.66
pH	5.90
Organic matter (%)	0.98
Cation Exchange capacity Cmol/kg^{-1}	6.00

TABLE 2: The main effects of some fertilizers on the growth of sesame (*Sesamum indicum L*) in Makurdi (2011)

Variety	LAF (cm^2)	LAM	PHF (cm)	PHM	NPB	D50% F	N LP F	SDM (cm)

E-8	109.4	137.4	32.88	137.8	7.17	34.75	161.7	4.32
SN 603	122.6	100.5	32.96	123.7	5.36	35.17	144.8	4.24
LSD (0.05)	N.S	36.13	N.S	NS	NS	NS	NS	NS
FERTILIZER								
INORGANIC	145.5	137.3	37.12	149.4	7.27	34.67	195.3	6.10
ORG. COMPOST	115.9	114.0	34.27	137.9	7.43	35.33	162.6	3.89
FOLIAR	102.4	104.1	30.27	117.8	5.92	34.83	132.8	3.81
CONTROL	100.1	120.5	30.02	117.7	4.43	35.00	122.2	3.33
LSD (0.05)	34.07	23.38	5.21	NS	1.83	NS	51.62	0.83

LSD=least significant difference, NS=not significant LAF=leaf area at flowering, LAM=leaf area at maturity, PHF=plant height at flowering, NPBF=number of primary branches at maturity, D50%F=days to fifty percent flowering, NLPF=number of leaves per plant at flowering, SDM=stem diameter at maturity

The result of the leaf area (LA) at flowering showed that there was no significant difference among the two varieties used in the experiment. Although there was no significant difference, the highest leaf area was obtained from SN603 (122.6cm^2) while E8 had the least (109.4cm^2). Among the fertilizer types, leaf area at flowering showed significant difference. The highest leaf area was obtained at inorganic fertilizers (145.5cm^2) followed by organic compost plus (115.9cm^2) and least was at control (100.1cm^2).The result of the plant height at flowering showed that there was no significant difference among the two sesame varieties. Although there was no significant difference, the highest plant height was obtained from SN603 (32.96cm) while E8 had the least (32.88cm). Among the fertilizer types, the result showed significant difference. The highest was obtained at inorganic fertilizers (37.12) followed by organic compost plus (34.27cm) and least at foliar (30.27cm). The result of plant height at maturity showed no significant difference among the two varieties used and even at the fertilizer types. The result of number of primary branches at maturity showed that there was no significant difference

among the two varieties used in the experiment. Although there was no significant difference among the varieties, the highest numbers of primary branches at maturity were obtained at E8 (7.17) while SN-603 had the least (5.36). Among the fertilizers types, the number of primary branches at maturity showed significant difference with the highest number of primary branches from organic compost plus (7.43) followed by inorganic fertilizer (7.27) and least was from control (4.43).

The result of the days to 50% flowering showed that there was no significant difference among the two varieties used in the experiment. Although there was no significance difference among the varieties, the highest was obtained from SN 603 (35.17) while E8 had the least at (34.75). Among the fertilizer types, days to 50% flowering also showed no significant difference although the highest days to 50% flowering were obtained from organic compost plus (35.33) and the least was from inorganic fertilizer (34.83). The result of the number of leaves per plant at flowering showed no significant difference among the varieties. Although there was no significant difference among the varieties, the highest number of leaves per plant at flowering was obtained from E8 (161.7) while SN603 had the least (144.8). Among the fertilizer types, the result showed significant difference. The highest number of leaves at flowering were obtained at inorganic fertilizer (195.3) followed by organic compost plus (162.6) and least at control (122.2). Stem diameter at maturity showed no significant difference among the two varieties. Among the fertilizer types, the stem diameter at maturity showed significant difference with the highest stem diameter from inorganic fertilizer (6.10cm) followed by organic compost plus (3.89cm) and least at control (3.33cm). The result of the days to maturity showed no significant difference among the two varieties used in the experiment although control matured earlier (97.7DAP) followed by foliar applied plots (99.7DAP) while plots applied with inorganic fertilizer matured last (106.7DAP).

Table 3: showed the means of the main effect of some fertilizer type on the yield and yield parameters of sesame (*Sesamum indicum L.*) in Makurdi 2011.

TABLE 3: The main effect of some fertilizers on the yield and yield parameters of Sesame (*Sesamumindicum L*) in Makurdi (2011)

VARIETY	No. of pods/plant	Capsule length (cm)	No.of seeds/ capsule	1000-seed wt.(g)	Seed yield (kg/ha)
E-8	95.9	1.99	62.3	2.70	271.0
SN 603	71.1	2.48	47.6	3.62	229.0
LSD (0.05)	NS	0.16	NS	0.96	NS
FERTILIZER					
INORGANIC	119.4	2.17	56.7	3.16	359.0
ORG. COMPOST	84.1	2.23	55.3	3.31	252.0
FOLIAR	72.5	2.38	64.7	3.02	194.0
CONTROL	69.9	2.15	43.1	3.15	195.0
LSD (0.05)	23.53	NS	10.6	NS	78.5

LSD=least significant difference, NS=not significant

The result of the number of pod/plant showed no significant difference between the varieties. Among the fertilizer types, there was significant difference. The highest number of pod/plant was obtained at inorganic fertilizer (119.4) followed by organic compost plus (84.1) and the least was from control (69.9). The result of the capsule length showed that there was significant difference among the varieties with the highest capsule length obtained from SN 603 (2.48cm) and least from E.8 (1.99cm). Among the fertilizer types, the capsule length also showed no significant difference with the highest capsule length obtained at foliar fertilizer (2.38cm) followed by organic compost plus at (2.23cm) and least was at control (2.15cm). Result of number of seeds/capsule, however, showed no significant difference among the two varieties used in the experiment. Among the fertilizer types, there was significant difference. The highest number of seeds/capsule was obtained from foliar fertilizer (64.7) followed by inorganic fertilizer (56.7) and the least was from control (43.1).

1000-seed weight showed significant difference with the highest weight of 1000 seeds obtained from SN 603 (36.2gm) and the least from E8 (2.7gm). Among the fertilizer types, the 1000-seed weight showed no significant difference. Although there was no significant difference, the highest seed weight was obtained at organic compost plus (3.31gm) followed by inorganic

fertilizer 3.16gm and least was from foliar fertilizer (3.02gm). The result of seed yield (kg/ha) showed that there was no significant difference among the two varieties used in the experiment. Although there was no significant difference among the varieties, the highest seed yield was obtained from E8 (271.0kg/ha) while SN603 had the least (229.0kg/ha). Among the fertilizer types, there was significant difference, the highest seed yield was obtained from inorganic fertilizer (359.0kg/ha) followed by organic compost plus (252.0kg/ha) and least was from foliar fertilizer (194.0kg/ha).

Table 4 showed the interaction effect of some varieties of sesame and fertilizer on the growth of sesame in Makurdi (2011).

TABLE 4: The interaction effect of some fertilizers on the growth of Sesame in Makurdi (2011)

Variety	LAF (cm^2)	LAM	PHF (cm)	PHM	NPBM	D50% F	N LP F	SDM (cm)	PHF (cm)
E8 x inorganic	140.5	163.1	37.07	158.5	8.80	34.33	222.0	6.17	106.03
E8 x compost	117.8	139.8	33.80	144.3	7.60	35.00	131.6	3.98	105.33
E8 x foliar	88.3	99.4	29.97	136.5	6.53	35.00	144.2	3.61	101.00
E8x control	90.9	147.4	30.67	111.8	5.73	34.67	149.1	3.50	98.00
SN603x inorganic	150.5	111.5	37.17	140.3	5.73	35.00	168.5	6.02	107.00
SN603x compost	114.1	88.3	34.73	131.6	7.27	35.67	193.6	3.80	1O2.33
SN603x foliar	116.5	108.7	30.57	99.1	5.30	34.67	121.5	4.00	98.33
SN603x control	109.3	93.6	29.37	123.6	3.13	35.33	95.4	3.16	107.00

LSD=least significant difference, NS=not significant

LAF=leaf area at flowering, LAM=leaf area at maturity, PHF=plant height at flowering, PHM=plant height at maturity, NPBF=number of primary branches at maturity, D50%F=days to fifty percent flowering, NLPF=number of leaves per plant at flowering, SDM=stem diameter at maturity

The result of the leaf area at flowering showed no significant difference at 5% level of probability. Although there was no significant difference among the interactions, the highest leaf area was obtained from SN603 x inorganic fertilizer (150.5

cm^2) followed by E8 x inorganic fertilizer (140.5cm^2) while the least was from E8 x foliar (88.3 cm^2). The result of the leaf area at maturity in the interaction showed that there was a significant difference. The highest leaf area (LA) was obtained at E8 and inorganic fertilizer (163.1cm^2) followed by E8 and control (147.4cm^2) while the least was from SN 603 and control (93.6cm^2). The result of the plant height at flowering and at maturity in the interaction showed no significant difference. The result of the number of primary branches at maturity also showed no significant difference. Although there was no statistical significant difference in the interaction, the highest number of primary branches at maturity was obtained from E8 and inorganic fertilizer (8.80) followed by E8 and organic compost plus (7.60) and least was at SN 603 and control (3.13). Result of the days to 50% flowering also showed no significant difference in the interaction, the highest days to 50 flowering was obtained from SN 603 and organic compost plus (35.67)and least was E8 x inorganic fertilizer (34.33)

Number of leaves/plant at flowering showed no significant difference interaction, although the highest number of leaves/plant at flowering was obtained from E8 x inorganic fertilizer (222.0) followed by SN603 and compost fertilizer (193.6) while the least was SN 603 and control (95.4). The result obtained from stem diameter at maturity in interaction showed no significant difference. Although there was no significant difference in the interaction, the highest stem diameter at maturity was obtained from E8 and inorganic fertilizer (6.17cm) followed by SN 603 and inorganic fertilizer (6.02cm) and the least SN 603 and control (3.16). The result of the days to maturity in the interaction showed that there was a significant difference. E8 x control matured earlier (98DAP) followed by SN603 x foliar (98.33DAP) while SN603 x inorganic and SN603 x control matured last (107.00)

Table 5: Shows the interaction effect of some varieties of sesame and fertilizer on the yield and yield parameters of sesame in Makurdi 2011.

TABLE 5: The interaction effect of some fertilizers on the yield & yield parameters of Sesame in Makurdi (2011)

Variety X Fertilizer	No. of pods/plant	Capsule length (cm)	No. of seeds/capsule	1000-seed weight (g)	Seed yield (kg/ha).
E8 x inorganic	136.4	1.97	69.3	2.62	396
E8x compost	92.6	2.00	61.3	2.86	262
E8x foliar	70.9	2.23	76.0	2.60	211
E8x control	83.7	1.77	42.7	2.51	214
SN603 x inorganic	102.5	2.37	44.0	3.50	3.22
SN603 x compost	75.6	2.45	49.3	3.75	242
SN603 x foliar	74.2	2.53	53.3	3.44	176
SN603 x control	56.1	2.53	43.6	3.78	176
LSD (0.05)	NS	NS	31.1	NS	NS

LSD=least significant difference, NS=not significant

The result of the number of pods/plant in the interaction showed that there was no significant difference. Although there was no significant difference, the highest number of pods/plant was obtained from E8 x inorganic fertilizer (136.4) followed by SN603 x inorganic fertilizer (102.5) while the least was obtained from SN603 and control (56.1). The result of the capsule length in the interaction showed no significant difference. Although there was no significant difference in the interactions, the highest capsule length was obtained from SN603 x foliar fertilizer and SN603 (2.53cm) followed by SN603 and organic compost plus (2.45cm) and least was at E8 and control (1.77).

The result of the number of seeds/capsules in the interaction showed that there was a significant difference. The highest number of seeds/capsules was obtained at E8 and foliar fertilizer (76.0) followed by E8 and inorganic fertilizer (69.3) while the least was obtained from E8 and control (42.7). Result of 1000-seed weight (g) in the interaction showed that there was no significant difference. Although there was no significant difference in the interaction, the

highest 1000-seed weight (g) in the interaction was obtained from SN603 x control (3.78gm) and least was obtained at E8 and control (2.51gm).The result of the seed yield showed that there was no significant difference. The highest seed yield was obtained from E8 x inorganic fertilizer (396kg/ha) and least was from SN603 and foliar fertilizer and SN 603 x control (176/kg/ha).

DISCUSSION

The result of the soil analysis at the beginning of the experiment showed that almost all the chemical properties were below the level required for optimum sesame growth and yield. For example, total soil nitrogen at the experimental site before the commencement of the research was low (7.3kg N/ha), which is below the critical soil N range (10.0-15.0 kg N/ha) as reported by Agboola and Fayemi (1972). This suggested that there is need to apply fertilizers for optimum yield to be obtained.This agrees with the report of Young *et al.* (2004) which states that "for optimum plant growth, nutrients must be available in sufficient and balanced quantities". The significant different observed at 0.5% level of probability at leaf area both at flowing and at maturity, plant height at flowering, number of primary branches, number of leaves at maturity stem diameter, days to maturity among the fertilizer types could be attributed to the fact that, the fertilizer types used in the experiment influence both growth and maturity of the two varieties of the sesame crop. This observation agrees with the findings of Sobulo and Babalola, (1991) which states that fertilizers improves soil and also crop growth. The study also observed early maturity in all varieties from control while those plots with fertilizers matured late especially for inorganic fertilizer. The reason for this observation could be that fertilizers delays maturity. The fact that plant height at flowering and maturity, number of leaves, days to maturity, number of primary branches, stem diameter does not show significance difference among the varieties could be attributed to the fact that the varieties difference did not contribute in the performance of the named parameter. That is to say genetically they are the same.

The result of the main effect of some fertilizer on the yield and yield parameter of sesame (S*esamum indicum* L.) in Makurdi).The non significant difference in the number of capsules, number of seeds capsule, and seed not

among the varieties but among the fertilizer types was an indication that the varieties do not contribute in the parameters. It therefore means that it is the different fertilizer types used determined the variation. Among the inorganic fertilizers, inorganic fertilizer (NPK 15:15:15 2bag/ha) contributed relatively better in all the above parameter. Capsule length and 1000 seed weight showed that there was a significant difference among the varieties but no significant difference was observed among the fertilizer types do not influence the capsule length (cm) and the 1000 seed weight (g). This could be that it is genetic composition of the varieties that made the difference observed.

The result of the interaction effect of same fertilizer types on the growth of sesame in Makurdi. Among the interactions, leaf area at flowering showed significant difference with E8 x Inorganic fertilizer having the highest leaf area at flowering. This implies that there was an interaction between the E8 and Inorganic fertilizer. It also suggests that E8 variety utilized the fertilizer better to develop the leaf area. At days to maturity the result showed an interaction between E8 and control which matured earlier than with fertilizers. This may imply that fertilizer influence days to maturity. The same trend was observed for variety SN 603 too. SN 603 and Control matured earlier than the rest with implies that fertilizer type influences the maturity period of the crop. In all interactions both varieties and control matured first, followed by the varieties and foliar, then by the varieties and organic compost and the last to mature was at both varieties and inorganic fertilizer. This could be an indication that application of inorganic fertilizer causes delay in sesame maturity.

The result of the interaction effect of some fertilizer types on the yield and yield parameters of sesame taken revealed that only number of seeds/capsule showed significant difference. This implies that the interaction between fertilizer types and the varieties of sesame influence the formation of number of seeds/capsules. Among the interactions, E8 x foliar fertilizer influences the formation of number of capsules per plant. Although it had the highest number of seeds/capsules but that does not translate to yield.

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