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NORTHEAST AGRICULTURAL CENTRE, MINISTRY OF AGRICULTURE AND COOPERATIVES
APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

COOPERATIVE RESEARCH PROGRAMME NO. 52
PRODUCTION AND UTILIZATION OF SUNFLOWER

RESEARCH PROJECT NO. 52/2
IMPROVEMENT OF CULTURAL PRACTICES OF SUNFLOWER

REPORT NO. 1
EFFECTS OF NITROGEN APPLICATION, SPACING, AND PLANTING METHOD ON TWO VARIETIES OF SUNFLOWER

BY
PRAWIT KRITTAYANAWACH
JIRAPORN CHANJANAKIJSKUL
BARRY NORMAN

ASRCT, BANGKOK 1974
not for publication

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CONTENTS

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By Prawit Krittayanawach*, Jiraporn Chanjanakijskul*, and Barry Norman+

SUMMARY

Two varieties of sunflower, Saratovskij and Sunfola have been studied on the effects of nitrogen fertilizer application, spacing, and planting method at Central Region Agricultural Centre at Chai Nat from February to June 1972. It was found that Saratovskij outyielded Sunfola in grain yield, good seed weight, 100 good seed weight, size of head and plant height. Single row/ridge planting produced good seed weight, 100 good seed weight, size of head and plant height better than double rows/ridge, but the latter gave more grain yield than the former. Spacing between plants at 6.25 cm apart produced better grain yield, good seed weight, 100 good seed weight, and size of head than those at 12.5 and 25 cm apart. Both varieties demonstrated significant gave responses to N fertilizer at 100 and 50 kg/ha.

INTRODUCTION

Sunflower (Helianthus annuus) is considered to be a promising crop under certain conditions: it grows well in less fertile soil under irrigation, and at least 500-600 mm of annual rainfall (Casallo 1963). The plant is basically believed to perform satisfactorily in all parts of Thailand. Previous observation indicated a good growth of sunflower at Chai Nat Province in the Central Plain of Thailand, however, the data on its yield were not available.

By having an aim to initiate commercial production of sunflower in Thailand, Applied Scientific Research Corporation of Thailand has started agronomic investigations on selected introduced varieties in 1971 (Chanjanakijskul 1972).

Klimov (1970) reported that the closest spacing gave the highest yields of seeds and oil of sunflower. Seed size and plant height were

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* Crops Research Group, Agricultural Products Research Institute, ASRCT.

+ Australian Columbo Plan Team at Central Region Agricultural Centre, Chai Nat.

increased by wider spacings, but head diameter oppositely performed. Also Skepasts (1966) found that the highest yields were obtained when plants were spaced 15-22.5 cm apart and 52.5-70 cm apart in row (133,000 plants/ha). Wider spacing encouraged large heads unsuitable for mechanical harvesting, since they mature and dry slowly. The smaller heads would be less susceptible to storm damage.

Shimanski (1965) reported the increase in oil yield, seed yield, protein content, and 100 seed weight can be achieved by nitrogen fertilization and wide spacing. Similarly McAllister (1970) showed that sunflowers exert their most critical demand on nitrogen during their first month of growth. Phosphorus supplementation should not be overlooked since the crop responds well to phosphate fertilizer especially on soil with a low phosphate level.

The experiment, the results of which are reported in this paper, was conducted at Central Region Agricultural Centre, Chai Nat on 12 February 1972 and harvested on 8 June 1972.

MATERIALS AND METHODS

(i) Materials

1) Sunflower variety Saratovskij and Sunfola were used.

2) Ammonium sulphate and superphosphate were used.

3) Ceresan and Captan (fungicide) were applied.

(ii) Methods

Design. Factorial arrangement within split plot design with 2 replications and 36 treatment combinations each.

Nitrogen	Spacing	Planting method	Variety
0 kg N/ha = N_0	6.25 cm = S_1	Single row/ridge = M_1	Saratovskij = V_1
50 kg N/ha = N_{50}	12.5 cm = S_2	Double rows/ridge = M_2	Sunfola = V_2
100 kg N/ha = N_{100}	25.0 cm = S_3		

Plot layout. Plot size = 5 ridges (3.75 m x 6 m) = 22.5 m^2

block = 22.5 m x 40 m = 900 m^2

total area = 900 m x 2 m = 1800 m^2

Four spare plots were added to every replication, thus a replication consisted of 40 plots.

Plot management. Seed was treated with Ceresan and Captan prior to sowing. Center band fertilization for both single row and double rows/ridge with ammonium sulphate at 50 kg N/ha and 100 kg N/ha respectively at sowing. Basal application of superphosphate was given at 30 kg P_2O_5/ha prior to sowing. The plots were irrigated every 10-14 days. Hand weeding were done as necessitated.

Measurement

1) Phenology: Data were collected on the number of days from planting to emergence, 10% and 50% bloom; and maturity.

2) Dry matter production of whole plants using plant samples harvested at full bloom from 3 ridges, 50 cm long at each end of the plot was made by means of N determination.

3) Plant height was determined at bud stage and at maturity.

4) Seed yield was harvested from central 3 ridges, 4 m long at maturity, of which the number of heads was counted.

5) Determinations of dry weight of seed per head, good seed per head, weight of 100 seeds, and head diameter were made.

RESULTS

(i) Yield

Table 1 demonstrates yields of Saratovskij and Sunfola treated with different planting methods, spacings, and nitrogen rates. From the analysis of variance (Table 2); varieties, planting methods, spacings, nitrogen rates, and their interactions were statistically different.

1) Variety: V_1 (Saratovskij) producing good seed of 1340.48 g/plot was significantly better than V_2 (Sunfola) with 1268.83 g/plot (Table 1).

TABLE 1. YIELD OF GOOD SEED OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER

(in gramme/plot)

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	No+N_{50}+N_{100}
V_1 (Saratovskij)	M_1 (1 row/ridge)	S_1 (6.25 cm)	638.85 ($V_1M_1S_1No$)	1590.95 ($V_1M_1S_1N_{50}$)	1670.05 ($V_1M_1S_1N_{100}$)	1299.95 ($V_1M_1S_1$)
		S_2 (12.5 cm)	535.70 ($V_1M_1S_2No$)	1670.55 ($V_1M_1S_2N_{50}$)	1713.55 ($V_1M_1S_2N_{100}$)	1306.60 ($V_1M_1S_2$)
		S_3 (25 cm)	503.05 ($V_1M_1S_3No$)	1715.85 ($V_1M_1S_3N_{50}$)	1767.30 ($V_1M_1S_3N_{100}$)	1328.73 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	559.20 (V_1M_1No)	1659.12 ($V_1M_1N_{50}$)	1716.97 ($V_1M_1N_{100}$)	1311.76 (V_1M_1)
	M_2 (2 rows/ridge)	S_1	711.00 ($V_1M_2S_1No$)	1802.85 ($V_1M_2S_1N_{50}$)	1967.10 ($V_1M_2S_1N_{100}$)	1493.65 ($V_1M_2S_1$)
		S_2	505.20 ($V_1M_2S_2No$)	1705.70 ($V_1M_2S_2N_{50}$)	1767.45 ($V_1M_2S_2N_{100}$)	1326.12 ($V_1M_2S_2$)
		S_3	513.35 ($V_1M_2S_3No$)	1689.75 ($V_1M_2S_3N_{50}$)	1710.65 ($V_1M_2S_3N_{100}$)	1304.44 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	576.52 (V_1M_2No)	1732.77 ($V_1M_2N_{50}$)	1815.07 ($V_1M_2N_{100}$)	1374.74 (V_1M_2)
	Average M_1+M_2	S_1	674.93 (V_1S_1No)	1696.90 ($V_1S_1N_{50}$)	1818.58 ($V_1S_1N_{100}$)	1396.80 (V_1S_1)
		S_2	520.45 (V_1S_2No)	1688.13 ($V_1S_2N_{50}$)	1740.50 ($V_1S_2N_{100}$)	1316.36 (V_1S_2)
		S_3	508.20 (V_1S_3No)	1702.80 ($V_1S_3N_{50}$)	1713.81 ($V_1S_3N_{100}$)	1308.27 (V_1S_3)
		Average ($S_1+S_2+S_3$)	567.86 (V_1No)	1695.94 (V_1N_{50})	1757.63 (V_1N_{100})	1340.48 (V_1)

TABLE 1. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_2 (Sunfola)	M_1	S_1	587.00 ($V_2M_1S_1No$)	1502.70 ($V_2M_1S_1N_{50}$)	1614.25 ($V_2M_1S_1N_{100}$)	1234.65 ($V_2M_1S_1$)
		S_2	510.40 ($V_2M_1S_2No$)	1563.30 ($V_2M_1S_2N_{50}$)	1682.10 ($V_2M_1S_2N_{100}$)	1251.93 ($V_2M_1S_2$)
		S_3	488.35 ($V_2M_1S_3No$)	1635.60 ($V_2M_1S_3N_{50}$)	1721.10 ($V_2M_1S_3N_{100}$)	1281.68 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	528.58 (V_2M_1No)	1567.20 ($V_2M_1N_{50}$)	1672.48 ($V_2M_1N_{100}$)	1256.09 (V_2M_1)
	M_2	S_1	665.15 ($V_2M_2S_1No$)	1684.35 ($V_2M_2S_1N_{50}$)	1771.55 ($V_2M_2S_1N_{100}$)	1373.68 ($V_2M_2S_1$)
		S_2	448.05 ($V_2M_2S_2No$)	1581.45 ($V_2M_2S_2N_{50}$)	1684.65 ($V_2M_2S_2N_{100}$)	1251.28 ($V_2M_2S_2$)
		S_3	477.80 ($V_2M_2S_3No$)	1553.85 ($V_2M_2S_3N_{50}$)	1627.30 ($V_2M_2S_3N_{100}$)	1219.65 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	543.67 (V_2M_2No)	1606.55 ($V_2M_2N_{50}$)	1694.50 ($V_2M_2N_{100}$)	1281.54 (V_2M_2)
	Average	S_1	626.08 (V_2S_1No)	1593.53 ($V_2S_1N_{50}$)	1692.90 ($V_2S_1N_{100}$)	1304.17 (V_2S_1)
		S_2	499.23 (V_2S_2No)	1572.38 ($V_2S_2N_{50}$)	1683.38 ($V_2S_2N_{100}$)	1251.66 (V_2S_2)
		S_3	483.08 (V_2S_3No)	1594.73 ($V_2S_3N_{50}$)	1674.20 ($V_2S_3N_{100}$)	1250.67 (V_2S_3)
		Average ($S_1+S_2+S_3$)	536.13 (V_2No)	1568.88 (V_2N_{50})	1683.49 (V_2N_{100})	1268.83 (V_2)

TABLE 1. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1+V_2	M_1	S_1	612.93 (M_1S_1No)	1546.83 ($M_1S_1N_{50}$)	1642.15 ($M_1S_1N_{100}$)	1267.30 (M_1S_1)
		S_2	523.05 (M_1S_2No)	1616.93 ($M_1S_2N_{50}$)	1699.10 ($M_1S_2N_{100}$)	1279.69 (M_1S_2)
		S_3	495.70 (M_1S_3No)	1675.73 ($M_1S_3N_{50}$)	1744.20 ($M_1S_3N_{100}$)	1305.21 (M_1S_3)
		Average ($S_1+S_2+S_3$)	543.89 (M_1No)	1613.16 (M_1N_{50})	1695.15 (M_1N_{100})	1284.07 (M_1)
	M_2	S_1	688.08 (M_2S_1No)	1743.60 ($M_2S_1N_{50}$)	1869.33 ($M_2S_1N_{100}$)	1433.67 (M_2S_1)
		S_2	496.63 (M_2S_2No)	1643.58 ($M_2S_2N_{50}$)	1726.05 ($M_2S_2N_{100}$)	1288.75 (M_2S_2)
		S_3	495.58 (M_2S_3No)	1621.80 ($M_2S_3N_{50}$)	1668.93 ($M_2S_3N_{100}$)	1262.12 (M_2S_3)
		Average ($S_1+S_2+S_3$)	560.10 (M_2No)	1669.66 (M_2N_{50})	1754.79 (M_2N_{100})	1328.18 (M_2)
	M_1+M_2	S_1	650.51 (S_1No)	1645.22 (S_1N_{50})	1755.74 (S_1N_{100})	1350.49 (S_1)
		S_2	509.84 (S_2No)	1630.26 (S_2N_{50})	1712.58 (S_2N_{100})	1284.23 (S_2)
		S_3	495.64 (S_3No)	1648.77 (S_3N_{50})	1706.59 (S_3N_{100})	1283.67 (S_3)
		Average ($S_1+S_2+S_3$)	552.00 (No)	1641.42 (N_{50})	1724.97 (N_{100})	GT(1306.13)

TABLE 1. Continued.

LSD for means of variety at	5% level	=	6.132
	1% level	=	11.156
LSD for means of planting method at	5% level	=	6.132
	1% level	=	11.256
LSD for means of variety x method at	5% level	=	8.671
	1% level	=	15.917
LSD for means of spacing or nitrogen rate at	5% level	=	5.961
	1% level	=	8.027
LSD for means of spacing x nitrogen at	5% level	=	10.322
	1% level	=	13.901
LSD for means of variety x spacing or variety x nitrogen rate or method x spacing or method x nitrogen rate at	5% level	=	8.425
	1% level	=	11.347
LSD for means of variety x method x spacing or variety x method x nitrogen rate at	5% level	=	11.917
	1% level	=	16.049
LSD for means of variety x spacing x nitrogen rate or method x spacing x nitrogen rate at	5% level	=	14.596
	1% level	=	19.657
LSD for means of variety x method x spacing x nitrogen rate at	5% level	=	20.624
	1% level	=	27.775

TABLE 2. ANALYSIS OF VARIANCE OF YIELD OF SUNFLOWER
(good seed/plot)

Source of variation	df	SS	MS	F
Block	1	15.03	15.03	-
Main plot (A)	3	(141554.42)		
Variety (V)	1	99748.11	99748.11	1492.56[1/]
Planting method (M)	1	35249.55	35249.55	527.45[1/]
V x M	1	6341.25	6341.25	94.88[1/]
Error (a)	3	200.48	66.83	-
Subplot (B)	8	(20683608.52)	-	-
Spacing (S)	2	71072.55	35536.28	347.74[1/]
Nitrogen (N)	2	20553176.66	10276588.33	100563.50[1/]
S x N	4	59359.31	41789.83	144.72[1/]
A x B	24	(211522.26)	-	-
V x S	2	2983.43	1491.72	14.59[1/]
M x S	2	142498.61	71249.31	697.22[1/]
V x M x S	2	898.15	449.08	4.39[2/]
V x N	2	18529.40	9264.70	90.66[1/]
M x N	2	7120.61	3560.31	34.84[1/]
V x M x N	2	4113.97	2056.99	20.12[1/]
V x S x N	4	3911.10	977.78	9.56[1/]
M x S x N	4	28827.79	7206.95	70.5[illegible][1/]
V x M x S x N	4	2639.20	659.80	6.45[1/]
Error (b)	32	3270.07	102.19	-
Total	71	21040170.98	-	-

[1/] Significance at 1% level.

[2/] Significance at 5% level.

CV(a) = 0.63%

CV(b) = 0.77%

2) Planting method: M_2 (2 rows/ridge) produced 1328.18 g of good seed while M_1 (1 row/ridge) produced 1284.07 g, the difference was significant (Table 1).

3) Spacing: S_1 (6.25 cm) gave 1350.49 g of good seed being significantly higher than S_2 (12.5 cm) and S_3 (25 cm). S_2 and S_3 did not differ statistically (Table 1).

4) Nitrogen rate: Significant differences were seen among yields of good seed produced by No (0 kg N/ha), N_{50} (50 kg N/ha), N_{100} (100 kg N/ha). N_{100} with 1724.97 g outyielded N_{50} (1641.42 g) and no (552.00 g) (Table 1).

5) Interaction:

First order:

Interaction between variety and planting method was seen significantly different. Among V_1M_1, V_1M_2, V_2M_1, and V_2M_2; V_1M_2 produced the highest good seed of 1374.74 g and the runners-up were V_1M_1 (1311.76 g), V_2M_2 (1281.54 g), and V_2M_1 (1256.09 g) respectively (Table 1).

Interaction between spacing and nitrogen rate also show significant difference except those between S_2No and S_3No, S_1N_{50} and S_3N_{50}, as well as S_1N_{100} and S_3N_{100} (Table 1).

Interaction between variety and spacing, especially both between V_1S_2 and V_1S_3, and between V_2S_2 and V_2S_3 were not significant different, but the rest were statistically seen different (Table 1).

Interactions between (a) planting method and spacing, (b) variety and nitrogen rate, (c) planting method and nitrogen rate of all comparisons showed highly significant difference (Table 1).

Second order:

Interactions between variety, planting method, and spacing; and between variety, planting method, and nitrogen rate showed significant difference except that between $V_1M_1S_1$ and $V_1M_1S_2$ (Table 1).

Interactions between variety, spacing, and nitrogen rate showed significant difference except those between $V_1S_2N_0$ and $V_1S_3N_0$, $V_1S_1N_{50}$ and $V_1S_2N_{50}$, $V_2S_1N_{50}$ and $V_2S_3N_{50}$, $V_2S_1N_0$ and $V_2S_1N_{100}$ and $V_2S_2N_{100}$, as well as $V_2S_2N_{100}$ and $V_2S_3N_{100}$ (Table 1).

Interactions between planting method, spacing, and nitrogen rate also demonstrated significant difference except that between $M_2S_2N_0$ and $M_2S_3N_0$ (Table 1).

Third order:

Interactions between variety, planting method, spacing, and nitrogen rate were significant different, however, some were not (Table 1).

(ii) Seed weight

Average of good seed weight of all treatments are given in Table 3. From the analysis of variance (Table 4); variety, planting method, spacing, nitrogen rate, and interactions of every order except interactions between variety, planting method, and spacing; interaction between variety, spacing, and nitrogen rate, were significant different.

1) Variety: V_1 (Saratovskij) producing good seed weight of 16.59 g/head was significantly better than V_2 (Sunfola) which produced 14.12 g/head.

2) Planting method: M_1 (single row/ridge) produced good seed of 18.67 g/head while M_2 (double rows/ridge) gave only 12.03 g/head, the difference was significant.

3) Spacing: S_1 produced the highest good seed weight per head (22.66 g). S_2 and S_3 yielded 14.19 and 9.22 g respectively.

4) Nitrogen rate: N_{100} produced the highest good seed weight of 23.56 g/head being followed consecutively by N_{50} and N_0.

5) Interaction:

First order:

Interactions between variety and planting method showed significant difference. Among four different treatments, V_1M_1 produced the highest good seed weight per head having V_2M_1, V_1M_2, and

TABLE 3. AVERAGE WEIGHT OF GOOD SEED/HEAD OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER
(in gramme)

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1 (Saratovskij)	M_1 (1 row/ridge)	S_1 (6.25 cm)	15.71 ($V_1M_1S_1No$)	31.04 ($V_1M_1S_1N_{50}$)	40.86 ($V_1M_1S_1N_{100}$)	29.20 ($V_1M_1S_1$)
		S_2 (12.5 cm)	5.53 ($V_1M_1S_2No$)	20.78 ($V_1M_1S_2N_{50}$)	28.49 ($V_1M_1S_2N_{100}$)	18.27 ($V_1M_1S_2$)
		S_3 (25 cm)	3.35 ($V_1M_1S_3No$)	14.96 ($V_1M_1S_3N_{50}$)	22.97 ($V_1M_1S_3N_{100}$)	13.76 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	8.20 (V_1M_1No)	22.26 ($V_1M_1N_{50}$)	30.77 ($V_1M_1N_{100}$)	20.41 (V_1M_1)
	M_2 (2 rows/ridge)	S_1 (6.25 cm)	10.18 ($V_1M_2S_1No$)	17.59 ($V_1M_2S_1N_{50}$)	31.82 ($V_1M_2S_1N_{100}$)	19.86 ($V_1M_2S_1$)
		S_2 (12.5 cm)	3.77 ($V_1M_2S_2No$)	11.54 ($V_1M_2S_2N_{50}$)	17.70 ($V_1M_2S_2N_{100}$)	11.00 ($V_1M_2S_2$)
		S_3 (25 cm)	2.30 ($V_1M_2S_3No$)	8.41 ($V_1M_2S_3N_{50}$)	11.49 ($V_1M_2S_3N_{100}$)	7.40 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	5.42 (V_1M_2No)	12.51 ($V_1M_2N_{50}$)	20.34 ($V_1M_2N_{100}$)	12.75 (V_1M_2)
	Average (M_1+M_2)	S_1	12.95 (V_1S_1No)	24.32 ($V_1S_1N_{50}$)	36.34 ($V_1S_1N_{100}$)	24.54 (V_1S_1)
		S_2	4.65 (V_1S_2No)	16.16 ($V_1S_2N_{50}$)	23.10 ($V_1S_2N_{100}$)	14.64 (V_1S_2)
		S_3	2.83 (V_1S_3No)	11.68 ($V_1S_3N_{50}$)	17.23 ($V_1S_3N_{100}$)	10.58 (V_1S_3)
		Average ($S_1+S_2+S_3$)	6.81 (V_1No)	17.39 (V_1N_{50})	25.56 (V_1N_{100})	16.59 (V_1)

TABLE 3. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N) No	N_{50}	N_{100}	Average $No+N_{50}+N_{100}$
V_2 (Sunfola)	M_1 (1 row/ridge)	S_1 (6.25 cm)	12.24 ($V_2M_1S_1No$)	25.11 ($V_2M_1S_1N_{50}$)	36.78 ($V_2M_1S_1N_{100}$)	24.71 ($V_2M_1S_1$)
		S_2 (12.5 cm)	6.93 ($V_2M_1S_2No$)	18.54 ($V_2M_1S_2N_{50}$)	24.15 ($V_2M_1S_2N_{100}$)	16.54 ($V_2M_1S_2$)
		S_3 (25 cm)	2.18 ($V_2M_1S_3No$)	9.74 ($V_2M_1S_3N_{50}$)	16.67 ($V_2M_1S_3N_{100}$)	9.53 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	7.12 (V_2M_1No)	17.80 ($V_2M_1N_{50}$)	25.87 ($V_2M_1N_{100}$)	16.93 (V_2M_1)
	M_2 (2 rows/ridge)	S_1 (6.25 cm)	8.00 ($V_2M_2S_1No$)	17.63 ($V_2M_2S_1N_{50}$)	24.88 ($V_2M_2S_1N_{100}$)	16.84 ($V_2M_2S_1$)
		S_2 (12.5 cm)	4.60 ($V_2M_2S_2No$)	11.06 ($V_2M_2S_2N_{50}$)	17.15 ($V_2M_2S_2N_{100}$)	10.94 ($V_2M_2S_2$)
		S_3 (25 cm)	1.64 ($V_2M_2S_3No$)	7.17 ($V_2M_2S_3N_{50}$)	9.69 ($V_2M_2S_3N_{100}$)	6.17 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	4.75 (V_2M_2No)	11.95 ($V_2M_2N_{50}$)	17.24 ($V_2M_2N_{100}$)	11.32 (V_2M_2)
	M_1+M_2	S_1	10.12 (V_2S_1No)	21.37 ($V_2S_1N_{50}$)	30.83 ($V_2S_1N_{100}$)	20.77 (V_2S_1)
		S_2	5.77 (V_2S_2No)	14.80 ($V_2S_2N_{50}$)	20.65 ($V_2S_2N_{100}$)	13.74 (V_2S_2)
		S_3	1.91 (V_2S_3No)	8.46 ($V_2S_3N_{50}$)	13.18 ($V_2S_3N_{100}$)	7.85 (V_2S_3)
		Average ($S_1+S_2+S_3$)	5.93 (V_2No)	14.88 (V_2N_{50})	21.55 (V_2N_{100})	14.12 (V_2)

TABLE 3. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1+V_2	M_1	S_1	13.98 (M_1S_1No)	28.08 ($M_1S_1N_{50}$)	38.82 ($M_1S_1N_{100}$)	26.96 (M_1S_1)
		S_2	6.23 (M_1S_1No)	19.66 ($M_1S_2N_{50}$)	26.32 ($M_1S_2N_{100}$)	17.40 (M_1S_2)
		S_3	2.77 (M_1S_3No)	12.35 ($M_1S_3N_{50}$)	19.82 ($M_1S_3N_{100}$)	11.65 (M_1S_3)
		Average ($S_1+S_2+S_3$)	7.66 (M_1No)	20.03 (M_1N_{50})	28.32 (M_1N_{100})	18.67 (M_1)
	M_2	S_1	9.09 (M_2S_1No)	17.61 ($M_2S_1N_{50}$)	28.35 ($M_2S_1N_{100}$)	18.35 (M_2S_1)
		S_2	4.19 (M_2S_2No)	11.30 ($M_2S_2N_{50}$)	17.43 ($M_2S_2N_{100}$)	10.97 (M_2S_2)
		S_3	1.97 (M_2S_3No)	7.79 ($M_2S_3N_{50}$)	10.59 ($M_2S_3N_{100}$)	6.78 (M_2S_3)
		Average ($S_1+S_2+S_3$)	5.08 (M_2No)	12.23 (M_2N_{50})	18.79 (M_2N_{100})	12.03 (M_2)
	M_1+M_2	S_1	11.54 (S_1No)	22.85 (S_1N_{50})	33.59 (S_1N_{100})	22.66 (S_1)
		S_2	5.21 (S_2No)	15.48 (S_2N_{50})	21.88 (S_2N_{100})	14.19 (S_1)
		S_3	2.37 (S_3No)	10.07 (S_3N_{50})	15.21 (S_3N_{100})	9.22 (S_3)
		Average ($S_1+S_2+S_3$)	6.37 (No)	16.13 (N_{50})	23.56 (N_{100})	15.36 (GT)

TABLE 3. Continued.

LSD for means of variety or planting method at	5% level	=	0.911
	1% level	=	1.332
LSD for means of spacing or nitrogen rate at	5% level	=	0.412
	1% level	=	0.556
LSD for means of variety x planting method at	5% level	=	1.028
	1% level	=	1.887
LSD for means of spacing x nitrogen rate at	5% level	=	0.715
	1% level	=	0.963
LSD for means of variety x spacing or variety x nitrogen rate or method x spacing or method x nitrogen rate at	5% level	=	0.584
	1% level	=	0.787
LSD for means of variety x method x nitrogen rate at	5% level	=	0.825
	1% level	=	1.111
LSD for means of method x spacing x nitrogen rate at	5% level	=	1.011
	1% level	=	1.361
LSD for means of variety x method x spacing x nitrogen rate at	5% level	=	1.429
	1% level	=	1.925

TABLE 4. ANALYSIS OF VARIANCE OF GOOD SEED WEIGHT/HEAD

Source of variation	df	SS	MS	F
Block	1		0.0613	0.0656
Main plot (A)	3	(923.0368)	-	-
Variety (V)	1	109.2735	109.2735	117.0077 1/
Planting method (M)	1	792.1527	792.1527	848.2200 1/
V x M	1	18.7476	18.7476	20.0745 1/
Error (a)	3	2.8017	0.9339	-
Subplot (B)	8	(5960.8051)	-	-
Spacing (S)	2	2216.4633	1108.2317	2258.9420 1/
Nitrogen (N)	2	3565.5979	1782.7990	3633.915 1/
S x N	4	178.7439	44.6860	91.0844 1/
A x B	24	(302.7409)	-	-
V x S	2	25.2414	12.6207	25.7250 1/
M x S	2	42.4371	21.2186	43.2503 1/
V x M x S	2	2.0977	1.0489	2.1380 NS
V x N	2	29.3323	14.6662	29.8944 1/
M x N	2	157.1627	78.5814	160.1740 1/
V x M x N	2	9.2902	4.6451	9.4682 1/
V x S x N	4	3.7583	0.9396	1.9152 NS
M x S x N	4	13.7554	3.4389	7.0095 1/
V x M x S x N	4	19.6658	4.9165	10.0214 1/
Error (b)	32	15.6984	0.4906	-
Total	71	7202.2812	-	-

1/ Significance at 1% level.

CV(a) = 6.32%

CV(b) = 4.55%

V_2M_2 as runner-up respectively (Table 3).

Interactions between spacing and nitrogen rate of all treatment combinations showed highly significant difference in good seed weight per head except that between S_2N_{50} and S_3N_{100}. S_1N_{100} produced the highest yield (33.59 g) and S_3N_0, the lowest (2.37 g) as shown in Table 3.

Interactions between variety and spacing demonstrated significant difference in all treatments. Table 3 shows that V_1S_1 produced the highest good seed weight per head (24.54 g).

Highly significant differences were visualized by the interactions between planting method and spacing so far as the good seed weight is concerned (Table 3).

Interactions between variety and nitrogen rate as well as between planting method and nitrogen rate were similar to those of the grain yield.

Second order:

Interactions between variety, planting method and spacing, and between variety, spacing, and nitrogen rate did not show significant difference (Table 4).

Some interactions between variety, planting method, and nitrogen rate were seen significant different, except those between $V_1M_2N_0$ and $V_2M_2N_0$, $V_1M_2N_{50}$ and $V_2M_2N_{50}$, $V_2M_1N_{50}$ and $V_2M_2N_{100}$ (Table 3).

Interactions between planting method, spacing, nitrogen rate showed mostly different in treatment mean comparisons except those between $M_1S_3N_0$ and $M_2S_3N_0$, $M_1S_1N_{50}$ and $M_2S_1N_{100}$, $M_1S_2N_{50}$ and $M_1S_3N_{100}$, $M_1S_3N_{50}$ and $M_2S_2N_{50}$, $M_2S_2N_{50}$ and $M_2S_3N_{100}$, $M_2S_1N_{50}$ and $M_2S_2N_{100}$ (Table 3).

Third order:

Third order interactions between variety, planting method, spacing, and nitrogen rate were similar to those of the grain yield.

(iii) 100 good seed weight

Weight of 100 good seeds of all treatment combinations are shown in Table 5. The analysis of variance (Table 6) shows that variety, planting method, spacing, nitrogen rate, and every order of interactions were significant different.

1) Variety: V_1 (Saratovskij) produced 4.46 g of 100 good seeds higher than V_2 (Sunfola) which produced 4.17 g of 100 good seeds.

2) Planting method: M_1 (single row/ridge) produced 100 good seed weight of 4.61 g while M_2 (double rows/ridge) produced 4.04 g. The difference was significant.

3) Spacing: Statistical differences were seen among the 100 good seed weight of all spacings. S_1 produced the highest weight of 4.81 g being followed by S_2 with 4.24 g and S_3 with 3.91 g.

4) Nitrogen rate: The 100 good seed weight of all N rates employed showed statistical differences. N_{100} with 5.31 g was the highest and No with 3.31 g, the lowest.

5) Interaction:

First order:

Interactions between variety and planting method were significantly different. Among the four treatment combinations, V_1M_1 produced the highest weight of 4.91 g and V_2M_1, V_2M_2, and V_1M_2 produced 4.29, 4.05, and 4.02 g respectively. However, the different between V_1M_2 and V_2M_2 was not significant (Table 5).

Interactions between spacing and nitrogen rate were significant different except that between S_1N_{50} and S_3N_{100}. S_1N_{100} with 6.06 g of 100 good seed weight was the highest. The runners-up were S_2N_{100} (5.05 g), S_3N_{100} (4.83 g), S_1N_{50} (4.79 g), S_2N_{50} (4.42 g), S_3N_{50} (3.83 g), S_1No (3.59 g), S_2No (3.25 g), and S_3No (3.08 g) respectively (Table 5).

Interactions between variety and spacing showed significant difference. V_1S_1 produced the highest weight of 100 good seeds while V_2S_3, the lowest (Table 5).

TABLE 5. WEIGHT OF 100 GOOD SEED OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER

(in gramme)

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1 (Saratovskij)	M_1	S_1 (6.25 cm)	3.85 ($V_1M_1S_1No$)	5.55 ($V_1M_1S_1N_{50}$)	6.75 ($V_1M_1S_1N_{100}$)	5.38 ($V_1M_1S_1$)
		S_2 (12.5 cm)	3.75 ($V_1M_1S_2No$)	5.45 ($V_1M_1S_2N_{50}$)	5.65 ($V_1M_1S_2N_{100}$)	4.95 ($V_1M_1S_2$)
		S_3 (25 cm)	3.30 ($V_1M_1S_3No$)	4.55 ($V_1M_1S_3N_{50}$)	5.35 ($V_1M_1S_3N_{100}$)	4.40 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	3.63 (V_1M_1No)	5.18 ($V_1M_1N_{50}$)	5.91 ($V_1M_1N_{100}$)	4.91 (V_1M_1)
	M_2 (2 rows/ridge)	S_1 (6.25 cm)	3.45 ($V_1M_2S_1No$)	4.45 ($V_1M_2S_1N_{50}$)	6.30 ($V_1M_2S_1N_{100}$)	4.73 ($V_1M_2S_1$)
		S_2 (12.5 cm)	3.00 ($V_1M_2S_2No$)	3.95 ($V_1M_2S_2N_{50}$)	4.35 ($V_1M_2S_2N_{100}$)	3.77 ($V_1M_2S_2$)
		S_3 (25 cm)	3.00 ($V_1M_2S_3No$)	3.65 ($V_1M_2S_3N_{50}$)	4.00 ($V_1M_2S_3N_{100}$)	3.55 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	3.15 (V_1M_2No)	4.02 ($V_1M_2N_{50}$)	4.88 ($V_1M_2N_{100}$)	4.02 (V_1M_2)
	Average M_1+M_2	S_1	3.65 (V_1S_1No)	5.00 ($V_1S_1N_{50}$)	6.53 ($V_1S_1N_{100}$)	5.06 (V_1S_1)
		S_2	3.38 (V_1S_2No)	4.70 ($V_1S_2N_{50}$)	5.00 ($V_1S_2N_{100}$)	4.36 (V_1S_2)
		S_3	3.15 (V_1S_3No)	4.10 ($V_1S_3N_{50}$)	4.68 ($V_1S_3N_{100}$)	3.98 (V_1S_3)
		Average ($S_1+S_2+S_3$)	3.39 (V_1No)	4.60 (V_1N_{50})	5.40 (V_1N_{100})	4.47 (V_1)

TABLE 5. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_2 (Sunfola)	M_1 (1 row/ridge)	S_1 (6.25 cm)	3.75 ($V_2M_1S_1No$)	4.70 ($V_2M_1S_1N_{50}$)	5.60 ($V_2M_1S_1N_{100}$)	4.68 ($V_2M_1S_1$)
		S_2 (12.5 cm)	3.05 ($V_2M_1S_2No$)	4.05 ($V_2M_1S_2N_{50}$)	5.35 ($V_2M_1S_2N_{100}$)	4.15 ($V_2M_1S_2$)
		S_3 (25 cm)	3.05 ($V_2M_1S_3No$)	3.85 ($V_2M_1S_3N_{50}$)	5.25 ($V_2M_1S_3N_{100}$)	4.05 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	3.28 (V_2M_1No)	4.20 ($V_2M_1N_{50}$)	5.40 ($V_2M_1N_{100}$)	4.29 (V_2M_1)
	M_2 (2 rows/ridge)	S_1 (6.25 cm)	3.30 ($V_2M_2S_1No$)	4.45 ($V_2M_2S_1N_{50}$)	5.55 ($V_2M_2S_1N_{100}$)	4.43 ($V_2M_2S_1$)
		S_2 (12.5 cm)	3.20 ($V_2M_2S_2No$)	4.20 ($V_2M_2S_2N_{50}$)	4.85 ($V_2M_2S_2N_{100}$)	4.08 ($V_2M_2S_2$)
		S_3 (25 cm)	2.95 ($V_2M_2S_3No$)	3.25 ($V_2M_2S_3N_{50}$)	4.70 ($V_2M_2S_3N_{100}$)	3.63 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	3.15 (V_2M_2No)	3.97 ($V_2M_2N_{50}$)	5.03 ($V_2M_2N_{100}$)	4.05 (V_2M_2)
	Average M_1+M_2	S_1	3.53 (V_2S_1No)	4.58 ($V_2S_1N_{50}$)	5.58 ($V_2S_1N_{100}$)	4.56 (V_2S_1)
		S_2	3.13 (V_2S_2No)	4.13 ($V_2S_2N_{50}$)	5.10 ($V_2S_2N_{100}$)	4.12 (V_2S_2)
		S_3	3.00 (V_2S_3No)	3.55 ($V_2S_3N_{50}$)	4.98 ($V_2S_3N_{100}$)	3.84 (V_2S_3)
		Average ($S_1+S_2+S_3$)	3.22 (V_2No)	4.09 (V_2N_{50})	5.22 (V_2N_{100})	4.17 (V_2)

TABLE 5. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	No+N_{50}+N_{100}
V_1+V_2	M_1	S_1	3.80 (M_1S_1No)	5.13 ($M_1S_1N_{50}$)	6.18 ($M_1S_1N_{100}$)	5.04 (M_1S_1)
		S_2	3.40 (M_1S_2No)	4.75 ($M_1S_2N_{50}$)	5.50 ($M_1S_2N_{100}$)	4.55 (M_1S_2)
		S_3	3.18 (M_1S_3No)	4.20 ($M_1S_3N_{50}$)	5.30 ($M_1S_3N_{100}$)	4.23 (M_1S_3)
		Average ($S_1+S_2+S_3$)	3.46 (M_1No)	4.69 (M_1N_{50})	5.66 (M_1N_{100})	4.61 (M_1)
	M_2	S_1	3.38 (M_2S_1No)	4.45 ($M_2S_1N_{50}$)	5.93 ($M_2S_1N_{100}$)	4.59 (M_2S_1)
		S_2	3.10 (M_2S_2No)	4.08 ($M_2S_2N_{50}$)	4.60 ($M_2S_2N_{100}$)	3.93 (M_2S_2)
		S_3	2.98 (M_2S_3No)	3.45 ($M_2S_3N_{50}$)	4.35 ($M_2S_3N_{100}$)	3.59 (M_2S_3)
		Average ($S_1+S_2+S_3$)	3.15 (M_2No)	3.99 (M_2N_{50})	4.96 (M_2N_{100})	4.04 (M_2)
	M_1+M_2	S_1	3.59 (S_1No)	4.79 (S_1N_{50})	6.06 (S_1N_{100})	4.81 (S_1)
		S_2	3.25 (S_2No)	4.42 (S_2N_{50})	5.05 (S_2N_{100})	4.24 (S_2)
		S_3	3.08 (S_3No)	3.83 (S_3N_{50})	4.83 (S_3N_{100})	3.91 (S_3)
		Average ($S_1+S_2+S_3$)	3.31 (No)	4.35 (N_{50})	5.31 (N_{100})	4.32 (GT)

TABLE 5. Continued.

LSD for means of variety or planting method at	5% level	=	0.124
	1% level	=	0.228
LSD for means of spacing or nitrogen rate at	5% level	=	0.041
	1% level	=	0.055
LSD for means of variety x planting method at	5% level	=	0.057
	1% level	=	0.105
LSD for means of spacing x nitrogen rate at	5% level	=	0.071
	1% level	=	0.096
LSD for means of variety x spacing or variety x nitrogen rate or method x spacing or method x nitrogen rate at	5% level	=	0.057
	1% level	=	0.077
LSD for means of variety x method x spacing or variety x method x nitrogen rate at	5% level	=	0.082
	1% level	=	0.110
LSD for means of variety x spacing x nitrogen rate or method x spacing x nitrogen rate at	5% level	=	0.100
	1% level	=	0.135
LSD for means of variety x method x spacing x nitrogen rate at	5% level	=	0.141
	1% level	=	0.190

TABLE 6. ANALYSIS OF VARIANCE OF 100 GOOD SEED WEIGHT

Source of variation	df	SS	MS	F
Block	1	0.01	0.01	-
Main plot (A)	3	(9.29)		
Variety (V)	1	1.53	1.530	530.00[1/]
Planting method (M)	1	5.84	5.840	1946.66[1/]
V x M	1	1.90	1.900	633.33[1/]
Error (a)	3	0.01	0.003	-
Subplot (B)	8	(59.87)	-	-
Spacing (S)	2	9.95	4.9750	1058.51[1/]
Nitrogen (N)	2	48.22	24.1100	5129.78[1/]
S x N	4	1.70	0.4250	90.42[1/]
A x B	24	(4.50)	-	-
V x S	2	0.43	0.2150	45.74[1/]
M x S	2	0.13	0.0650	13.82[1/]
V x M x S	2	0.49	0.2450	52.12[1/]
V x N	2	0.46	0.2300	48.93[1/]
M x N	2	0.61	0.3050	64.89[1/]
V x M x N	2	0.25	0.1250	26.59[1/]
V x S x N	4	1.42	0.3550	75.53[1/]
M x S x N	4	0.54	0.1350	28.72[1/]
V x M x S x N	4	0.27	0.0675	14.36[1/]
Error (b)	32	0.15	0.0047	-
Total	71	73.91	-	-

[1/] Significance at 1% level.

CV(a) = 1.27%

CV(b) = 1.60%

Interactions between planting method and spacing were significant different except that between M_1S_1 and M_2S_1. As shown in Table 5, M_1S_1 produced the highest 100 good seed weight (5.04 g) followed by M_2S_1 (4.59 g), M_1S_2 (4.55 g), M_1S_3 (4.23 g), M_2S_2 (3.93 g), and M_2S_3, the lowest (3.59 g).

Interactions between variety and nitrogen rate showed highly significant difference. V_1N_{100} produce the highest 100 good seed weight and V_2No, the lowest (Table 5).

Table 5 also shows that all interactions between planting method and nitrogen rate were statistically different.

Second order:

Interactions between variety, planting method, and spacing showed significant difference in certain combinations except those between $V_1M_2S_1$ and $V_2M_1S_1$, $V_2M_2S_1$ and $V_1M_1S_3$, $V_2M_1S_2$ and $V_2M_2S_2$, and $V_2M_2S_2$ and $V_2M_1S_3$ (Table 5).

Interactions between variety, spacing, and nitrogen rate also showed significant difference, except those between V_1S_3No and $V_2S_2N_{50}$, $V_1S_1N_{50}$ and $V_1S_2N_{100}$, $V_1S_1N_{50}$ and $V_2S_2N_{100}$, $V_1S_2N_{100}$ and $V_2S_2N_{100}$, $V_1S_1N_{50}$ and $V_2S_2N_{100}$, $V_1S_2N_{100}$ and $V_2S_2N_{100}$ (Table 5).

Interactions between planting method, spacing, and nitrogen rate also demonstrated significantly difference except those between M_1S_2No and M_2S_1No, M_1S_3No and M_2S_2No, M_1S_2No and $M_2S_1N_{50}$ as seen in Table 5.

Third order:

Interactions between variety, planting method, spacing, and nitrogen rate were mostly significant different (Table 5).

(iv) Size of head

From the analysis of variance (Table 7), only variety, spacing, nitrogen rate, interaction between spacing and nitrogen rate, and interaction between planting method and nitrogen rate were seen significant different. The result of least significant difference (LSD) of these treatment means were as follows:

TABLE 7. ANALYSIS OF VARIANCE OF SIZE OF HEAD OF SUNFLOWER (in centimetre)

Source of variation	df	SS	MS	F
Block	1	0.1335	0.1335	0.3330
Main plot (A)	3	(43.6459)	-	-
Variety (V)	1	0.6938	0.6938	1.7410^{NS}
Planting method (M)	1	40.8307	40.4307	101.4572$^{1/}$
V x M	1	0.7923	0.7923	1.9882^{NS}
Error (a)	3	1.1956	0.3985	-
Subplot (B)	8	(247.6129)	-	-
Spacing (S)	2	81.6612	40.8306	108.7945$^{1/}$
Nitrogen (N)	2	160.6605	80.3303	214.0428$^{1/}$
S x N	4	5.2912	1.3228	3.5246$^{2/}$
A x B	24	(17.1888)	-	-
V x S	2	1.0415	0.5208	1.3876^{NS}
M x S	2	1.5611	0.7806	2.0799^{NS}
V x M x S	2	0.7244	0.3622	0.9650^{NS}
V x N	2	0.7164	0.3582	0.9544^{NS}
M x N	2	5.9385	2.9693	7.9118$^{1/}$
V x M x N	2	0.1979	0.0990	0.0263^{NS}
V x S x N	4	3.3863	0.8466	2.2557^{NS}
M x S x N	4	2.5021	0.6255	1.6666^{NS}
V x M x S x N	4	1.1206	0.2802	0.7466^{NS}
Error (b)	32	12.0096	0.3753	-
Total	71	320.4572	-	-

$^{1/}$Significance at 1% level.

$^{2/}$Significance at 5% level.

CV(a) = 9.43%

CV(b) = 8.94%

1) Planting method: M_1 (single row/ridge) produced a head diameter of 7.60 cm which was bigger than M_2 (double rows/ridge) with 6.10 cm (Table 8).

2) Spacing: A head size of 8.26 cm was obtained from spacing 6.25 cm between plants, while smaller heads were produced by spacings 12.5 cm and 25 cm respectively (Table 8).

3) Nitrogen application at 100 kg N/ha produced the biggest head of 8.46 cm while those at 50 and 0 kg N/ha produced smaller heads (Table 8).

4) Interaction:

First order:

Interactions between spacing and nitrogen rate were significant different except those between S_1N_0 and S_3N_{50}, S_2N_{50} and S_3N_{100} (Table 8).

Some interactions between planting method and nitrogen rate demonstrated statistical difference so far as size of head was concerned (Table 8).

(v) Plant height

The analysis of variance (Table 9) shows that variety, planting method, spacing, nitrogen rate and most of their interactions were statistically significant different. Data on plant height as influenced by these treatment combinations are given in Table 10.

1) Variety: V_1 (Saratovskij) was 151.57 cm high and significantly higher than V_2 (Sunfola) with 107.40 cm high.

2) Planting method: M_1 (single row/ridge) produced a plant height of 136.22 cm which was significantly higher than M_2 (double rows/ridge) with 122.76 cm high.

3) Spacing: S_2 (12.5 cm between plants) gave the highest plant. S_1 and S_3 gained the same height, however S_3 tended to be higher than S_1.

4) Nitrogen rate produced significant differences among treatment combinations. N_{100} gave the highest plant being followed by N_{50} and No respectively.

TABLE 8. SIZE OF HEAD OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER

(in centimetre)

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1 (Saratovskij)	M_1	S_1	6.14 ($V_1M_1S_1No$)	9.82 ($V_1M_1S_1N_{50}$)	11.95 ($V_1M_1S_1N_{100}$)	9.30 ($V_1M_1S_1$)
		S_2	4.73 ($V_1M_1S_2No$)	8.10 ($V_1M_1S_2N_{50}$)	9.52 ($V_1M_1S_2N_{100}$)	7.45 ($V_1M_1S_2$)
		S_3	4.86 ($V_1M_1S_3No$)	6.83 ($V_1M_1S_3N_{50}$)	8.22 ($V_1M_1S_3N_{100}$)	6.64 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	5.24 (V_1M_1No)	8.25 ($V_1M_1N_{50}$)	9.90 ($V_1M_1N_{100}$)	7.80 (V_1M_1)
	M_2	S_1	5.51 ($V_1M_2S_1No$)	7.64 ($V_1M_2S_1N_{50}$)	8.68 ($V_1M_2S_1N_{100}$)	7.28 ($V_1M_2S_1$)
		S_2	3.74 ($V_1M_2S_2No$)	5.99 ($V_1M_2S_2N_{50}$)	7.57 ($V_1M_2S_2N_{100}$)	5.77 ($V_1M_2S_2$)
		S_3	4.14 ($V_1M_2S_3No$)	5.53 ($V_1M_2S_3N_{50}$)	6.10 ($V_1M_2S_3N_{100}$)	5.26 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	4.46 (V_1M_2No)	6.39 ($V_1M_2N_{50}$)	7.45 ($V_1M_2N_{100}$)	6.10 (V_1M_2)
	Average M_1+M_2	S_1	5.83 (V_1S_1No)	8.73 ($V_1S_1N_{50}$)	10.31 ($V_1S_1N_{100}$)	8.19 (V_1S_1)
		S_2	4.24 (V_1S_2No)	7.05 ($V_1S_2N_{50}$)	8.55 ($V_1S_2N_{100}$)	6.61 (V_1S_2)
		S_3	4.50 (V_1S_3No)	6.18 ($V_1S_3N_{50}$)	7.16 ($V_1S_3N_{100}$)	5.95 (V_1S_3)
		Average ($S_1+S_2+S_3$)	4.86 (V_1No)	7.32 (V_1N_{50})	8.68 (V_1N_{100})	6.95 (V_1)

TABLE 8. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N) No	N_{50}	N_{100}	Average $No+N_{50}+N_{100}$
V_2 (Sunfola)	M_1	S_1	5.82 ($V_2M_1S_1No$)	10.09 ($V_2M_1S_1N_{50}$)	11.24 ($V_2M_1S_1N_{100}$)	9.05 ($V_2M_1S_1$)
		S_2	6.05 ($V_2M_1S_2No$)	7.47 ($V_2M_1S_2N_{50}$)	8.34 ($V_2M_1S_2N_{100}$)	7.29 ($V_2M_1S_2$)
		S_3	3.73 ($V_2M_1S_3No$)	6.09 ($V_2M_1S_3N_{50}$)	7.73 ($V_2M_1S_3N_{100}$)	5.85 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	5.20 (V_2M_1No)	7.88 ($V_2M_1N_{50}$)	9.10 ($V_2M_1N_{100}$)	7.40 (V_2M_1)
	M_2	S_1	5.62 ($V_2M_2S_1No$)	7.31 ($V_2M_2S_1N_{50}$)	9.25 ($V_2M_2S_1N_{100}$)	7.39 ($V_2M_2S_1$)
		S_2	4.55 ($V_2M_2S_2No$)	6.28 ($V_2M_2S_2N_{50}$)	6.84 ($V_2M_2S_2N_{100}$)	5.89 ($V_2M_2S_2$)
		S_3	3.39 ($V_2M_2S_3No$)	5.52 ($V_2M_2S_3N_{50}$)	6.04 ($V_2M_2S_3N_{100}$)	4.98 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	4.52 (V_2M_2No)	6.37 ($V_2M_2N_{50}$)	7.38 ($V_2M_2N_{100}$)	6.09 (V_2M_2)
	Average M_1+M_2	S_1	5.72 (V_2S_1No)	8.70 ($V_2S_1N_{50}$)	10.25 ($V_2S_1N_{100}$)	12.34 (V_2S_1)
		S_2	5.30 (V_2S_2No)	6.88 ($V_2S_2N_{50}$)	7.59 ($V_2S_2N_{100}$)	9.89 (V_2S_2)
		S_3	3.56 (V_2S_3No)	5.81 ($V_2S_3N_{50}$)	6.89 ($V_2S_3N_{100}$)	8.13 (V_2S_3)
		Average ($S_1+S_2+S_3$)	4.86 (V_2No)	7.13 (V_2N_{50})	8.24 (V_2N_{100})	10.12 (V_2)

TABLE 8. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1+V_2	M_1	S_1	5.98 (M_1S_1No)	9.96 ($M_1S_1N_{50}$)	11.60 ($M_1S_1N_{100}$)	9.18 (M_1S_1)
		S_2	5.39 (M_1S_2No)	7.79 ($M_1S_2N_{50}$)	8.93 ($M_1S_2N_{100}$)	7.37 (M_1S_2)
		S_3	4.30 (M_1S_3No)	6.46 ($M_1S_3N_{50}$)	7.98 ($M_1S_3N_{100}$)	6.25 (M_1S_3)
		Average ($S_1+S_2+S_3$)	5.22 (M_1No)	8.07 (M_1N_{50})	9.50 (M_1N_{100})	7.60 (M_1)
	M_2	S_1	5.57 (M_2S_1No)	7.48 ($M_2S_1N_{50}$)	8.97 ($M_2S_1N_{100}$)	7.34 (M_2S_1)
		S_2	4.15 (M_2S_2No)	6.14 ($M_2S_2N_{50}$)	7.21 ($M_2S_2N_{100}$)	5.83 (M_2S_2)
		S_3	3.77 (M_2S_3No)	5.53 ($M_2S_3N_{50}$)	6.07 ($M_2S_3N_{100}$)	5.12 (M_2S_3)
		Average ($S_1+S_2+S_3$)	4.50 (M_2No)	6.38 (M_2N_{50})	7.42 (M_2N_{100})	6.10 (M_2)
	M_1+M_2	S_1	5.78 (S_1No)	8.72 (S_1N_{50})	10.29 (S_1N_{100})	8.26 (S_1)
		S_2	4.77 (S_2No)	6.97 (S_2N_{50})	8.07 (S_2N_{100})	6.60 (S_2)
		S_3	4.04 (S_3No)	6.00 (S_3N_{50})	7.03 (S_3N_{100})	5.69 (S_3)
		Average ($S_1+S_2+S_3$)	4.86 (No)	7.23 (N_{50})	8.46 (N_{100})	6.85

TABLE 8. Continued.

LSD for means of planting method at	5% level	=	0.474
	1% level	=	0.870
LSD for means of spacing or nitrogen rate at	5% level	=	0.361
	1% level	=	0.487
LSD for all means of spacing x nitrogen rate at	5% level	=	0.627
	1% level	=	0.824
LSD for all means of planting method x nitrogen rate at	5% level	=	1.613
	1% level	=	2.173

TABLE 9. ANALYSIS OF VARIANCE OF PLANT HEIGHT

Source of variation	df	SS	MS	F
Block	1	40.35	40.35	0.857
Main plot (A)	3	(38933.49)	-	-
Variety (V)	1	35125.75	35125.75	745.928 1/
Planting method (M)	1	3262.98	3262.98	69.292 1/
V x M	1	363.15	363.15	7.712 NS
Error (a)	3	141.26	47.09	-
Subplot (B)	8	(41076.58)	-	-
Spacing (S)	2	99.94	49.97	6.262 1/
Nitrogen (N)	2	40042.52	20021.26	2508.930 1/
S x N	4	934.12	133.53	16.733 1/
A x B	24	(6028.62)	-	-
V x S	2	748.43	374.22	46.895 1/
M x S	2	6.83	3.42	0.429 NS
V x M x S	2	11.65	5.83	0.731 NS
V x N	2	2233.22	1116.61	139.926 1/
M x N	2	442.17	221.09	27.706 1/
V x M x N	2	234.07	117.04	14.667 1/
V x S x N	4	1272.90	318.23	39.878 1/
M x S x N	4	985.14	246.29	30.863 1/
V x M x S x N	4	94.21	23.55	2.951 2/
Error (b)	32	255.33	7.98	-
Total	71	86294.02	-	-

1/ Significance at 1% level.

2/ Significance at 5% level.

CV(a) = 5.33%

CV(b) = 2.00%

TABLE 10. PLANT HEIGHT OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER

(in centimetre)

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	No, N_{50}+N_{100}
V_1	M_1	S_1	116.05 ($V_1M_1S_1No$)	161.75 ($V_1M_1S_1N_{50}$)	185.50 ($V_1M_1S_1N_{100}$)	154.43 ($V_1M_1S_1$)
		S_2	102.05 ($V_1M_1S_2No$)	190.05 ($V_1M_1S_2N_{50}$)	198.45 ($V_1M_1S_2N_{100}$)	163.52 ($V_1M_1S_2$)
		S_3	129.30 ($V_1M_1S_3No$)	173.00 ($V_1M_1S_3N_{50}$)	188.80 ($V_1M_1S_3N_{100}$)	163.70 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	115.80 (V_1M_1No)	174.93 ($V_1M_1N_{50}$)	190.92 ($V_1M_1N_{100}$)	160.55 (V_1M_1)
	M_2	S_1	118.75 ($V_1M_2S_1No$)	131.15 ($V_1M_2S_1N_{50}$)	162.35 ($V_1M_2S_1N_{100}$)	137.42 ($V_1M_2S_1$)
		S_2	102.55 ($V_1M_2S_2No$)	152.20 ($V_1M_2S_2N_{50}$)	182.30 ($V_1M_2S_2N_{100}$)	145.68 ($V_1M_2S_2$)
		S_3	104.10 ($V_1M_2S_3No$)	157.95 ($V_1M_2S_3N_{50}$)	172.00 ($V_1M_2S_3N_{100}$)	144.68 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	108.47 (V_1M_2No)	147.10 ($V_1M_2N_{50}$)	172.22 ($V_1M_2N_{100}$)	142.59 (V_1M_2)
	Average M_1+M_2	S_1	117.40 (V_1S_1No)	146.45 ($V_1S_1N_{50}$)	173.93 ($V_1S_1N_{100}$)	145.93 (V_1S_1)
		S_2	102.30 (V_1S_2No)	171.13 ($V_1S_2N_{50}$)	190.38 ($V_1S_2N_{100}$)	154.60 (V_1S_2)
		S_3	116.70 (V_1S_3No)	165.48 ($V_1S_3N_{50}$)	180.40 ($V_1S_3N_{100}$)	154.19 (V_1S_3)
		Average ($S_1+S_2+S_3$)	112.13 (V_1No)	161.02 (V_1N_{50})	181.57 (V_1N_{100})	151.57 (V_1)

TABLE 10. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_2	M_1	S_1	84.10 ($V_2M_1S_1No$)	121.35 ($V_2M_1S_1N_{50}$)	142.00 ($V_2M_1S_1N_{100}$)	115.12 ($V_2M_1S_1$)
		S_2	87.70 ($V_2M_1S_2No$)	119.20 ($V_2M_1S_2N_{50}$)	127.00 ($V_2M_1S_2N_{100}$)	111.30 ($V_2M_1S_2$)
		S_3	90.85 ($V_2M_1S_3No$)	112.80 ($V_2M_1S_3N_{50}$)	121.95 ($V_2M_1S_3N_{100}$)	108.53 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	87.55 (V_2M_1No)	117.78 ($V_2M_1N_{50}$)	130.32 ($V_2M_1N_{100}$)	111.88 (V_2M_1)
	M_2	S_1	81.55 ($V_2M_2S_1No$)	107.00 ($V_2M_2S_1N_{50}$)	128.05 ($V_2M_2S_1N_{100}$)	105.53 ($V_2M_2S_1$)
		S_2	82.15 ($V_2M_2S_2No$)	101.85 ($V_2M_2S_2N_{50}$)	127.60 ($V_2M_2S_2N_{100}$)	103.87 ($V_2M_2S_2$)
		S_3	74.05 ($V_2M_2S_3No$)	108.70 ($V_2M_2S_3N_{50}$)	115.25 ($V_2M_2S_3N_{100}$)	99.33 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	79.25 (V_2M_2No)	105.85 ($V_2M_2N_{50}$)	123.63 ($V_2M_2N_{100}$)	102.91 (V_2M_2)
	Average M_1+M_2	S_1	82.83 (V_2S_1No)	114.18 ($V_2S_1N_{50}$)	135.03 ($V_2S_1N_{100}$)	110.68 (V_2S_1)
		S_2	84.93 (V_2S_2No)	110.53 ($V_2S_2N_{50}$)	127.30 ($V_2S_2N_{100}$)	107.59 (V_2S_2)
		S_3	82.45 (V_2S_3No)	110.75 ($V_2S_3N_{50}$)	118.60 ($V_2S_3N_{100}$)	103.93 (V_2S_3)
		Average ($S_1+S_2+S_3$)	83.40 (V_2No)	111.82 (V_2N_{50})	126.98 (V_2N_{100})	107.40 (V_2)

TABLE 10. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	No+N_{50}+N_{100}
V_1+V_2	M_1	S_1	100.08 (M_1S_1No)	141.55 ($M_1S_1N_{50}$)	163.75 ($M_1S_1N_{100}$)	135.13 (M_1S_1)
		S_2	94.88 (M_1S_2No)	154.63 ($M_1S_2N_{50}$)	162.73 ($M_1S_2N_{100}$)	137.41 (M_1S_2)
		S_3	110.08 (M_1S_3No)	142.90 ($M_1S_3N_{50}$)	155.38 ($M_1S_3N_{100}$)	136.12 (M_1S_3)
		Average ($S_1+S_2+S_3$)	101.68 (M_1No)	146.36 (M_1N_{50})	160.62 (M_1N_{100})	136.22 (M_1)
	M_2	S_1	100.15 (M_2S_1No)	119.08 ($M_2S_1N_{50}$)	145.20 ($M_2S_1N_{100}$)	121.48 (M_2S_1)
		S_2	92.35 (M_2S_2No)	127.03 ($M_2S_2N_{50}$)	154.95 ($M_2S_2N_{100}$)	124.78 (M_2S_2)
		S_3	89.08 (M_2S_3No)	133.32 ($M_2S_3N_{50}$)	143.63 ($M_2S_3N_{100}$)	122.01 (M_2S_3)
		Average ($S_1+S_2+S_3$)	93.86 (M_2No)	126.48 (M_2N_{50})	147.93 (M_2N_{100})	122.76 (M_2)
	M_1+M_2	S_1	100.12 (S_1No)	130.32 (S_1N_{50})	154.48 (S_1N_{100})	128.31 (S_1)
		S_2	93.62 (S_2No)	140.83 (S_2N_{50})	158.84 (S_2N_{100})	131.10 (S_2)
		S_3	99.58 (S_3No)	138.11 (S_3N_{50})	149.50 (S_3N_{100})	129.06 (S_3)
		Average ($S_1+S_2+S_3$)	97.77 (No)	136.42 (N_{50})	154.27 (N_{100})	129.49

TABLE 10. Continued.

LSD for means of variety or planting method at	5% level	=	5.155
	1% level	=	9.462
LSD for means of spacing or nitrogen rate at	5% level	=	1.674
	1% level	=	2.255
LSD for means of spacing x nitrogen rate at	5% level	=	2.655
	1% level	=	3.575
LSD for means of variety x spacing or variety x nitrogen rate or method x nitrogen rate at	5% level	=	2.348
	1% level	=	3.163
LSD for means of variety x method x nitrogen rate at	5% level	=	3.328
	1% level	=	4.483
LSD for means of variety x spacing x nitrogen rate or method x spacing x nitrogen rate at	5% level	=	4.084
	1% level	=	5.500
LSD for means of variety x method x spacing x nitrogen rate at	5% level	=	2.655
	1% level	=	3.575

5) Interaction:

First order:

Interactions between spacing and nitrogen rate showed statistical difference, except that between S_1No and S_3No (Table 9).

Interactions between variety and spacing were significant different except that between V_1S_2 and V_1S_3 (Table 9).

Interactions between variety and nitrogen rate also showed significant difference (Table 9).

Interactions between planting method and nitrogen rate were also significant different except that between M_1N_{50} and M_2N_{100} (Table 9).

Second order:

Table 9 shows that interactions between variety, planting method, and nitrogen rate were significant except those between $V_1M_1N_{50}$ and $V_1M_2N_{100}$, V_1M_1No and $V_2M_1N_{50}$.

Table 9 further indicates that interactions between planting method, spacing, and nitrogen rate can be seen in certain treatment combinations.

Third order:

Interactions between variety, planting method, spacing, and nitrogen rate mostly gained significant difference.

(vi) Nitrogen percentage at blooming stage

The analysis of variance which is given in Table 11 shows significant difference only on variety, nitrogen rate, interactions between spacing and nitrogen rate, and between variety and nitrogen rate. Table 12 presents the data on nitrogen percentage.

1) Variety: V_2 (Sumfola) had 1.35% nitrogen in plant at blooming stage while V_1 (Saratovskij) had 0.93%.

2) Nitrogen rate produced significant differences among treatments. N_{100} gave the highest nitrogen in plant, N_{50} and No were the runners-up respectively.

TABLE 11. ANALYSIS OF VARIANCE OF NITROGEN PERCENTAGE AT BLOOMING STAGE

Source of variation	df	SS	MS	F
Block	1	0.0078	0.0078	0.7429^{NS}
Main plot (A)	3	(3.1871)	-	-
Variety (V)	1	3.1458	3.1458	299.6000$^{1/}$
Planting method (M)	1	0.0086	0.0086	0.8190^{NS}
V x M	1	0.0933	0.0933	8.8857^{NS}
Error (a)	3	0.0316	0.0105	-
Subplot (B)	8	(3.0637)	-	-
Spacing (S)	2	0.0265	0.0133	0.8365^{NS}
Nitrogen (N)	2	0.8324	1.4162	89.0692$^{1/}$
S x N	4	0.2048	0.0512	3.2201$^{2/}$
A x B	24	(0.8508)	-	-
V x S	2	0.0262	0.0131	0.8239^{NS}
M x S	2	0.0956	0.0478	3.0063^{NS}
V x M x S	2	0.0214	0.0107	0.6730^{NS}
V x N	2	0.4257	0.2129	13.3899$^{1/}$
M x N	2	0.0938	0.0469	2.9497^{NS}
V x M x N	2	0.0445	0.0223	1.4025^{NS}
V x S x N	4	0.0247	0.0062	0.3899^{NS}
M x S x N	4	0.0647	0.0162	1.0189^{NS}
V x M x S x N	4	0.0542	0.0136	0.8553^{NS}
Error (b)	32	0.5099	0.0159	-
Total	71	7.7115	-	-

$^{1/}$Significance at 1% level.

$^{2/}$Significance at 5% level.

CV(a) = 9.0%

CV(b) = 11.05%

TABLE 12. NITROGEN PERCENTAGE AT BLOOMING STAGE OF SARATOVSKIJ AND SUNFOLA AT LEVELS OF PLANTING METHOD, SPACING, AND NITROGENOUS FERTILIZER

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1	M_1	S_1	0.82 ($V_1M_1S_1No$)	0.91 ($V_1M_1S_1N_{50}$)	1.06 ($V_1M_1S_1N_{100}$)	0.93 ($V_1M_1S_1$)
		S_2	0.77 ($V_1M_1S_2No$)	0.81 ($V_1M_1S_2N_{50}$)	1.19 ($V_1M_1S_2N_{100}$)	0.92 ($V_1M_1S_2$)
		S_3	0.75 ($V_1M_1S_3No$)	0.80 ($V_1M_1S_3N_{50}$)	0.86 ($V_1M_1S_3N_{100}$)	0.80 ($V_1M_1S_3$)
		Average ($S_1+S_2+S_3$)	0.78 (V_1M_1No)	0.84 ($V_1M_1N_{50}$)	1.04 ($V_1M_1N_{100}$)	0.88 (V_1M_1)
	M_2	S_1	0.77 ($V_1M_2S_1Nc$)	0.87 ($V_1M_2S_1N_{50}$)	1.15 ($V_1M_2S_1N_{100}$)	0.93 ($V_1M_2S_1$)
		S_2	0.83 ($V_1M_2S_2No$)	0.93 ($V_1M_2S_2N_{50}$)	1.36 ($V_1M_2S_2N_{100}$)	1.04 ($V_1M_2S_2$)
		S_3	0.85 ($V_1M_2S_3No$)	0.98 ($V_1M_2S_3N_{50}$)	1.09 ($V_1M_2S_3N_{100}$)	0.97 ($V_1M_2S_3$)
		Average ($S_1+S_2+S_3$)	0.82 (V_1M_2No)	0.93 ($V_1M_2N_{50}$)	1.20 ($V_1M_2N_{100}$)	0.98 (V_1M_2)
	Average M_1+M_2	S_1	0.80 (V_1S_1No)	0.89 ($V_1S_1N_{50}$)	1.11 ($V_1S_1N_{100}$)	0.93 (V_1S_1)
		S_2	0.80 (V_1S_2No)	0.87 ($V_1S_2N_{50}$)	1.28 ($V_1S_2N_{100}$)	0.98 (V_1S_2)
		S_3	0.80 (V_1S_3No)	0.89 ($V_1S_3N_{50}$)	0.98 ($V_1S_3N_{100}$)	0.89 (V_1S_3)
		Average ($S_1+S_2+S_3$)	0.80 (V_1No)	0.88 (V_1N_{50})	1.12 (V_1N_{100})	0.93 (V_1)

TABLE 12. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_2	M_1	S_1	1.13 ($V_2M_1S_1No$)	1.69 ($V_2M_1S_1N_{50}$)	1.71 ($V_2M_1S_1N_{100}$)	1.41 ($V_2M_1S_1$)
		S_2	1.06 ($V_2M_1S_2No$)	1.29 ($V_2M_1S_2N_{50}$)	1.86 ($V_2M_1S_2N_{100}$)	1.40 ($V_2M_1S_2$)
		S_3	1.09 ($V_2M_1S_3No$)	1.41 ($V_2M_1S_3N_{50}$)	1.43 ($V_2M_1S_3N_{100}$)	1.31 ($V_2M_1S_3$)
		Average ($S_1+S_2+S_3$)	1.09 (V_2M_1No)	1.36 ($V_2M_1N_{50}$)	1.67 ($V_2M_1N_{100}$)	1.37 (V_2M_1)
	M_2	S_1	0.92 ($V_2M_2S_1No$)	1.38 ($V_2M_2S_1N_{50}$)	1.64 ($V_2M_2S_1N_{100}$)	1.31 ($V_2M_2S_1$)
		S_2	0.92 ($V_2M_2S_2No$)	1.37 ($V_2M_2S_2N_{50}$)	1.57 ($V_2M_2S_2N_{100}$)	1.29 ($V_2M_2S_2$)
		S_3	0.82 ($V_2M_2S_3No$)	1.52 ($V_2M_2S_3N_{50}$)	1.71 ($V_2M_2S_3N_{100}$)	1.35 ($V_2M_2S_3$)
		Average ($S_1+S_2+S_3$)	0.89 (V_2M_2No)	1.42 ($V_2M_2N_{50}$)	1.64 ($V_2M_2N_{100}$)	1.32 (V_2M_2)
	Average M_1+M_2	S_1	1.03 (V_2S_1No)	1.39 ($V_2S_1N_{50}$)	1.68 ($V_2S_1N_{100}$)	1.37 (V_2S_1)
		S_2	0.99 (V_2S_2No)	1.33 ($V_2S_2N_{50}$)	1.72 ($V_2S_2N_{100}$)	1.35 (V_2S_2)
		S_3	0.96 (V_2S_3No)	1.47 ($V_2S_3N_{50}$)	1.57 ($V_2S_3N_{100}$)	1.33 (V_2S_3)
		Average ($S_1+S_2+S_3$)	0.99 (V_2No)	1.40 (V_2N_{50})	1.66 (V_2N_{100})	1.35 (V_2)

TABLE 12. Continued.

Variety	Planting method (M)	Spacing (S)	Nitrogen (kg/ha) (N)			Average
			No	N_{50}	N_{100}	$No+N_{50}+N_{100}$
V_1+V_2	M_1	S_1	0.98 (M_1S_1No)	1.15 ($M_1S_1N_{50}$)	1.39 ($M_1S_1N_{100}$)	1.17 (M_1S_1)
		S_2	0.92 (M_1S_2No)	1.05 ($M_1S_2N_{50}$)	1.53 ($M_1S_2N_{100}$)	1.17 (M_1S_2)
		S_3	0.92 (M_1S_3No)	1.11 ($M_1S_3N_{50}$)	1.15 ($M_1S_3N_{100}$)	1.06 (M_1S_3)
		Average ($S_1+S_2+S_3$)	0.94 (M_1No)	1.10 (M_1N_{50})	1.36 (M_1N_{100})	1.13 (M_1)
	M_2	S_1	0.85 (M_2S_1No)	1.13 ($M_2S_1N_{50}$)	1.40 ($M_2S_1N_{100}$)	1.13 (M_2S_1)
		S_2	0.88 (M_2S_2No)	1.15 ($M_2S_2N_{50}$)	1.47 ($M_2S_2N_{100}$)	1.17 (M_2S_2)
		S_3	0.83 (M_2S_3No)	1.25 ($M_2S_3N_{50}$)	1.40 ($M_2S_3N_{100}$)	1.16 (M_2S_3)
		Average ($S_1+S_2+S_3$)	0.85 (M_2No)	1.18 (M_2N_{50})	1.42 (M_2N_{100})	1.15 (M_2)
	Average M_1+M_2	S_1	0.92 (S_1No)	1.14 (S_1N_{50})	1.40 (S_1N_{100})	1.15 (S_1)
		S_2	0.90 (S_2No)	1.10 (S_2N_{50})	1.50 (S_2N_{100})	1.17 (S_2)
		S_3	0.88 (S_3No)	1.18 (S_3N_{50})	1.28 (S_3N_{100})	1.11 (S_3)
		Average ($S_1+S_2+S_3$)	0.90 (No)	1.14 (N_{50})	1.39 (N_{100})	1.14

TABLE 12. Continued.

LSD for means of variety at	5% level	=	0.076
	1% level	=	0.140
LSD for means of nitrogen rate at	5% level	=	0.076
	1% level	=	0.102
LSD for all means of spacing x nitrogen rate at	5% level	=	0.129
	1% level	=	0.173
LSD for all means of variety x nitrogen rate at	5% level	=	0.106
	1% level	=	0.143

3) Interactions:

First order:

There appeared a significant interaction between spacing and nitrogen rate only in the combination of S_3N_{50} and S_3N_{100} (Table 12).

Interactions between variety and nitrogen rate were significant different except that between V_1N_0 and V_1N_{50}.

DISCUSSION

The result of this study variously indicates better performance of Saratovskij over Sunfola as far as grain yield, good seed/head, 100 good seed weight, size of head and plant height, are concerned. However, Sunfola accumulated more nitrogen than did Saratovskij. A conclusion can be made, therefore, that Saratovskij was adaptable to this environmental condition.

Single row per ridge planting produced good seed/head, 100 good seed weight, size of head and plant height better than double rows per ridge planting. But these planting methods did not influence the accumulation of nitrogen in plant, although double rows/ridge tended to show more accumulation than single row/ridge. It is significant that if ridge planting is to be employed, double rows per ridge is productive.

Taking the spacing into consideration, the study indicated that 6.25 cm between plants produced higher grain yield than wider spacing. It is obvious that good seed weight/head, 100 good seed weight were increased by closer spacing; this agrees well with Klimov (1970). Skepasts (1966) reported that wider spacing encouraged large heads unsuitable for mechanization, since they mature and dry slowly. However, in USSR, recommended spacing for seed crops was 60 x 40 cm.

Nitrogen fertilization markedly influenced the grain yield, good seed/head, 100 good seed weight, size of head, plant height and nitrogen percentage at blooming stage. At the rate of 100 kg/ha the fertilizer gave significant response over those at the rate of 50 kg/ha and nil. However, it should be noted that the increment of yield between the

control and 50 kg N/ha plots was higher than that between 100 kg N/ha and 50 kg N/ha plots. This indicates that studies on fertilizer application should be further conducted prior to making recommendation.

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