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# Effect of Genotypes on Spacing and Nipping with Different Levels of Nutrients on Growth and Yield of Castor (*Ricinus communis* L.)

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**ABSTRACT**

*A field experiment was conducted on the performance of genotypes and row spacings with nipping practices and different levels of nutrients at the Agricultural College Farm, UAS, Raichur, during kharif 2016 and 2017 in the clay soil. Pooled mean of two years indicated that DCH-519 recorded significantly higher total number of productive spikes plant$^{-1}$ (9.04), number of capsules spike$^{-1}$ (35.25), bean yield (1311 kg ha$^{-1}$), net returns (₹ 21,074 ha$^{-1}$) and BC ratio (2.24) as compared to DCH-177. Among the row spacings, 120 cm with nipping recorded significantly higher number of capsules spike$^{-1}$ (42.10) whereas the bean yield (1700 kg ha$^{-1}$), net returns (₹ 31899 ha$^{-1}$) and BC ratio (2.83) was significantly higher with a row spacing of 90 cm with nipping. Similarly 100 per cent RDF with sulphur recorded significantly higher total number of productive spikes plant$^{-1}$ (9.33), number of capsules spike$^{1}$ (36.14), bean yield (1356 kg ha$^{-1}$) and net returns (₹ 21831 ha$^{-1}$) whereas BC ratio was significantly higher with 100 per cent RDF without sulphur (2.53). Hence, on the basis of the results obtained in the pooled data of the two years, genotype DCH-519 with a row spacing of 90 cm with nipping and 100 per cent RDF was found to be economical and better option to obtain higher bean yield.*

***Key words:*** *Nipping, Ricinus communis, Geometry and Bean yield, Nutrient levels*

## INTRODUCTION

Castor (*Ricinus communis* L.) is the most primitive non-edible crop belonging to family Euphorbiaceae grown under tropical, sub-tropical and temperate regions. Seeds of this crop were found during excavation in Egypt, Sudan, India and in ancient agricultural dwellings of North West Asia and Iran. As a non-edible and industrial crop, castor plays an important role in Indian economy because of better export potential. During 2014-15, the country earned a foreign exchange worth of ₹ 4364.33 crores through export of castor oil and cake[2]. Yield of any crop is a function of yield per plant and number of plants from unit area. Therefore, the optimum plant population for a particular region with specific variety must be determined for maximum yield and efficient utilization of land.

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The castor plant being perennial in nature is capable of producing branches from every auxillary bud that appears on its main axis. The lower shoots that develop from the auxillary buds many a times produce spikes not as much effective as main spike. Hence, periodical nipping *i.e*., removal of auxillary buds assumes importance in maintaining optimum source to sink relationship. There is a vast scope to increase the productivity of castor by adopting latest and improved scientific agro-techniques like periodical nipping, use of high yielding varieties, suitable planting geometry and nutrient levels.

## MATERIAL AND METHODS

A field experiment was conducted in *kharif* 2016 and 2017 on medium deep black clay soils at the Agricultural College Farm, UAS, Raichur, Karnataka. The experiment was carrid out in Split-Split plot design. Castor (genotypes DCH-177 and DCH-519) as a main plot with two row spacings of 90 and 120 cm and nipping as a sub plot. Sub-sub plot consists of 75 (56:38:18 kg ha$^{-1}$) and 100 per cent (75:50:25 kg ha$^{-1}$) recommended dose of fertilizers half of nitrogen, entire dose of phosphorus and potassium in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP) and the remaining 50 % nitrogen was top dressed at 30 and 40 DAS and gypsum was applied at 100 kg ha$^{-1}$ at 30 DAS. The experimental soil was alkaline in reaction (pH 8.3) and (EC 0.32 dSm$^{-1}$). It was also low in available nitrogen (226 kg ha$^{-1}$), medium in available phosphorus (29 kg ha$^{-1}$), Potash (320 kg ha$^{-1}$) and sulphur (18 ppm). The recommended packages of practices were followed. The cost includes expenditure on seeds, fertilizers, weed management and plant protection chemicals. At maturity, the crop was harvested and plot wise yields were recorded. The data recorded at different stages of crop was subjected to statistical analysis at 5 % probability.

## RESULTS AND DISCUSSION

### Performance of castor genotypes

In the current investigation, castor hybrid DCH-519 stood out to be superior interms of growth parameters *viz*. plant height (189.25 cm), number of branches plant$^{-1}$ (14.59) and number of leaves plant$^{-1}$ (23.43) over DCH 177 at harvest (Table 1). DCH-519 recorded significantly higher total number of productive spikes plant$^{-1}$ (9.04) number of capsules spike$^{-1}$ (35.25) and bean yield (1311 kg ha$^{-1}$) over DCH-177 in pooled data (Table 2). The bean yield of castor was significantly higher in castor hybrid DCH-519 (1311 kg ha$^{-1}$) over DCH-177. The higher yield could be attributed to higher plant height, number of branches and leaves per plant and cumulative effect of yield attributes. Indeed, the yield of crop is a function of yield attributes like number of productive spikes plant$^{-1}$ and number of capsules spike$^{-1}$ which were higher in DCH-519 which ultimately resulted in higher bean yield. The genotype DCH-177 is a poor yielder because of its poor growth and canopy makeup. Similar results were reported by Govindan *et al*.[4], Shifa[15] and Sannappa *et al*.[14]. Highest net returns and BC ratio was realized with DCH-519 (₹ 21,074 ha$^{-1}$ and 2.24) over DCH-177 (₹ 19,265 and 2.13) (Table 3) the increase in net returns and BC ratio is due to better performance of the hybrid DCH-519 by producing higher number of productive spikes plant$^{-1}$ and number of capsules plant$^{-1}$ which inturn increased the yield.

### Row spacing and nipping

Plant height, number of leaves and number of branches plant$^{-1}$ at harvest were significantly influenced due to varying inter-row spacing and nipping practices. Significantly higher plant height was concurred with row spacing of 90 cm without nipping (195.14 cm) over 90 cm with nipping (186.66 cm) and 120 cm with and without nipping (181.02 and 189.57 cm, respectively) (Table 1). This might be due to increasing intra-plant competition for sunlight necessary for photosynthesis, which enables the plant to increase their height. Similar findings were also reported by Vala *et al*.[23] and Rana *et al*.[13]. Number of branches (17.34) and leaves plant$^{-1}$ (27.12) were significantly higher with 120 cm × 60 cm without nipping as compared to a row spacing of 90 cm with and without nipping and 120 cm with nipping. Inversely to plant height, increase in inter-row spacing from 90 cm to 120 cm, there was positive increase in growth parameters like number of branches and leaves plant$^{-1}$. On an average, 120 cm inter-row spacing without nipping recorded 10.65, 30.27, 57.35 per cent more branches plant$^{-1}$ as compared to row spacing of 90 cm without nipping, 120 and 90 cm with nipping at harvest, respectively. Being indeterminate plant, increased space availability for individual plant reduced competition for nutrients, light and water, resulted into increased growth of castor. The growth parameters are also supportive to each other as number of leaves increases the photosynthesis, which increases the food availability and thereby increases the plant growth in different parts. Sundaresan *et al*.[19], Narkhede *et al*.[10], Thododa[22] and Singh[17] observed similar pattern of positive growth response to wider spacings. Significantly lower plant height was observed in the nipped castor plants (Table 1). Same treatment recorded significantly minimum number of leaves and branches plant$^{-1}$ during all the growth stages. According to Patel *et al*.[11] this might be due to early loss of apical dominance which led to shorter main stem which ultimately resulted into reduced number of nodes and thus recorded minimum number of leaves and branches in nipped plants.

Among the row spacing with nipping practices, total number of productive spikes plant$^{-1}$ (11.11) and number of capsules spike$^{-1}$ (42.10) were significantly higher with a row spacing of 120 cm without nipping as compared to a row spacing of 120 cm with nipping and 90 cm with and without nipping whereas the bean yield was significantly higher with a row spacing of 90 cm with nipping as compared to 90 cm without nipping and 120 cm with and without nipping. Yield attributes and yield differed in response to spacing and nipping. Among yield attributing characters, total number of productive spikes plant$^{-1}$ and number of capsules spike$^{-1}$ were significantly higher with wider spacing of 120 cm x 60 cm and decreased with reducing the row spacing. This might be due to greater availability of space and nutrients and less intra and inter plant competition at low plant density. Narkhede *et al*.[10], Thodada *et al*.[22] and Sudha Rani[18] also reported similar results. The mean bean yield advantage under 90 cm x 60 cm with nipping was to the tune of 21.34, 52.46 and 88.88 per cent. The results corroborate with the early findings of Raghavaiah and Sudhakara Babu[12], Lakshmi and Reddy[7] and Rana *et al*.[13]. Treatments with periodical nipping recorded significantly higher bean yield as against non-nipping. Nipping and maintaining only the primary spikes often produced higher yield as reported by Hanumantha Rao *et al*.[5]. Spacing of 90 cm x 60 cm with nipping accrued maximum net realization of ₹ 31899 ha$^{-1}$ with BC ratio of 2.83 (Table 3). This treatment increased the additional net realization to the tune of 35.33, 105.16 and 230.25 per cent, respectively over row spacing of 120 cm with nipping, 90 cm and 120 cm without nipping, respectively. The increase in net profit was attributed to larger yield differences with minute variation in cost of production under different spacing with nipping**.** Singh[17] and Tank *et al*.[21] also reported similar results.

**Nutrient management**

Plant height, number of leaves and branches plant$^{-1}$ at harvest were significantly influenced by NPK and S fertilization. Application of 100% RDF with sulphur recorded significantly higher plant height (189.98 cm), number of branches (14.82) and number of leaves plant$^{-1}$ (23.76) as compared to 100 per cent RDF without sulphur and 75 per cent RDF with and without sulphur (Table 1). Increased levels of N, P and K might have resulted in more root proliferation and vigorous seedling growth, which in turn was useful for higher uptake of moisture and nutrients from soil reservoir. These findings are in close conformity with those of Hussaini *et al*.[6] and Suryavanshi *et al*.[20]. Similarly total number of productive spikes plant$^{-1}$ (9.33), number of capsules spike$^{-1}$ (36.14) and bean yield (1356 kg ha$^{-1}$) increased with 100 per cent RDF with sulphur as compared to 100 per cent RDF without sulphur and 75 per cent RDF with and without sulphur. Yield attributing characters of castor *viz*., number of spikes plant$^{-1}$ and number of capsules spike$^{-1}$ significantly declined with reducing NPK fertilization from 100% RDF to 75% RDF which resulted in lower bean yield of castor. These results are also corroborated with those of Mathukia and Modhwadia[8] and

Mathukia *et al*[9]. Gross returns, net returns and rupee per rupee invested were worked out for different levels of N, P, K and S fertilizer schedules (Table 3). Among the different nutrient levels with sulphur application, 100% RDF with sulphur recorded significantly higher net returns (₹ 21,831 ha$^{-1}$) which was closely followed by 100% RDF without sulphur application (₹ 21,665 ha$^{-1}$) . With respect to BC ratio, 100% RDF without sulphur recorded higher BC ratio (2.53) which was closely followed by 100% RDF with sulphur (2.49). The higher BC ratio was recorded in these treatments because of least cost incurred for the cultivation of castor. Similar results were also reported by Akbari *et al*.[1] and Babu *et al*[3].

**Interaction of genotypes, row spacing with nipping and different levels of nutrients**

Bean yield was recorded significantly higher with a row spacing of 90 cm with nipping with the application of 100% RDF with sulphur (1783 kg ha$^{-1}$) (Table 3) this is because a plant population of 90 cm × 60 cm increased the number of spikes per plant and number of capsules per plant as a result of increase in the growth parameters like plant height per plant which increased the bean yield as compared to a row spacing of 120 cm. Treatments with periodical staggered nipping recorded significantly higher bean yield as against non-nipping. Nipping and maintaining only the primary spikes often produced higher yield as reported by Hanumantha Rao *et al*[5]. Whereas, Venkate Gowda *et al*.[24], Shivaramu and Krishna Murthy[16] reported almost 200 per cent increase in castor yield through periodical staggered nipping and maintaining four to five spikes plant$^{-1}$). Economic analysis is of paramount importance as it gives the clear picture about cost involved, income and their ratio which are of vital importance from farmer's point of view. Spacing of 90 cm x 60 cm and nipping with 100% RDF with sulphur accrued maximum net realization of ₹ 33,735 ha$^{-1}$). The increase in net profit was attributed to larger yield differences with minute variation in cost of production under different spacings with nipping Singh[17] and Tank *et al*.[21] also reported similar results. BC ratio was recorded higher with a row spacing of 90 cm and nipping with 100% RDF without sulphur (2.91) (Table 3) this increase in the BC ratio was due to lesser cost of cultivation incurred in this treatment.

**Table 1: Plant height, number of branches plant$^{-1}$ and number of leaves plant$^{-1}$ of castor genotypes as influenced by spacing with nipping practices and nutrition at harvest**

| G x S x F | | Plant height (cm) at harvest | | | | | Number of branches at harvest | | | | | Number of leaves at harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S |
| $G_1$ | $S_1$ | 187.78 | 187.61 | 184.90 | 184.61 | 186.22 | 11.25 | 11.25 | 10.37 | 10.20 | 10.77 | 19.55 | 19.35 | 17.83 | 17.60 | 18.58 |
| | $S_2$ | 195.66 | 195.22 | 193.35 | 193.24 | 194.37 | 15.90 | 15.81 | 15.03 | 14.98 | 15.43 | 24.34 | 24.30 | 23.00 | 23.00 | 23.66 |
| | $S_3$ | 182.77 | 182.63 | 180.78 | 180.50 | 181.67 | 13.60 | 13.51 | 12.55 | 12.42 | 13.02 | 22.02 | 22.00 | 21.00 | 21.00 | 21.51 |
| | $S_4$ | 191.33 | 191.16 | 189.12 | 189.03 | 190.16 | 17.50 | 17.50 | 16.71 | 16.63 | 17.08 | 27.60 | 27.56 | 26.05 | 25.88 | 26.77 |
| $G_2$ | $S_1$ | 188.19 | 188.06 | 186.10 | 186.04 | 187.10 | 11.75 | 11.66 | 10.85 | 10.80 | 11.26 | 20.25 | 20.10 | 19.00 | 19.00 | 19.59 |
| | $S_2$ | 197.87 | 197.75 | 194.06 | 194.00 | 195.92 | 16.43 | 16.40 | 15.44 | 15.35 | 15.90 | 25.28 | 25.20 | 23.98 | 23.78 | 24.56 |
| | $S_3$ | 184.00 | 183.77 | 181.80 | 181.54 | 182.78 | 14.28 | 14.11 | 13.00 | 13.00 | 13.60 | 22.60 | 22.35 | 21.89 | 21.68 | 22.13 |
| | $S_4$ | 192.28 | 192.11 | 190.33 | 190.12 | 191.21 | 17.88 | 17.85 | 17.37 | 17.27 | 17.59 | 28.45 | 28.40 | 26.50 | 26.50 | 27.46 |
| F | | 189.98 | 189.79 | 187.55 | 187.38 | | 14.82 | 14.76 | 13.91 | 13.83 | | 23.76 | 23.66 | 22.41 | 22.30 | |
| | | G x F | | | | G | G x F | | | | G | G x F | | | | G |
| $G_1$ | | 189.38 | 189.15 | 187.04 | 186.84 | 188.10 | 14.56 | 14.52 | 13.67 | 13.56 | 14.07 | 23.38 | 23.30 | 21.97 | 21.87 | 22.63 |
| $G_2$ | | 190.58 | 190.42 | 188.07 | 187.93 | 189.25 | 15.08 | 15.00 | 14.16 | 14.10 | 14.59 | 24.14 | 24.01 | 22.84 | 22.74 | 23.43 |
| | | S x F | | | | S | S x F | | | | S | S x F | | | | S |
| $S_1$ | | 187.98 | 187.84 | 185.50 | 185.33 | 186.66 | 11.50 | 11.46 | 10.61 | 10.50 | 11.02 | 19.90 | 19.73 | 18.41 | 18.30 | 19.08 |
| $S_2$ | | 196.77 | 196.48 | 193.70 | 193.62 | 195.14 | 16.16 | 16.11 | 15.23 | 15.16 | 15.67 | 24.81 | 24.75 | 23.49 | 23.39 | 24.11 |
| $S_3$ | | 183.38 | 183.20 | 181.29 | 181.02 | 182.22 | 13.94 | 13.81 | 12.78 | 12.71 | 13.31 | 22.31 | 22.18 | 21.45 | 21.34 | 21.82 |
| $S_4$ | | 191.80 | 191.63 | 189.73 | 189.57 | 190.68 | 17.69 | 17.68 | 17.04 | 16.95 | 17.34 | 28.02 | 27.98 | 26.28 | 26.19 | 27.12 |
| Interactions | | S.Em.± | | | C.D. (0.05) | | S.Em. ± | | | C.D. (0.05) | | S.Em. ± | | | C.D. (0.05) | |
| Genotype | | 0.14 | | | 0.85 | | 0.06 | | | 0.36 | | 0.10 | | | 0.62 | |
| Spacing | | 0.18 | | | 0.54 | | 0.07 | | | 0.20 | | 0.10 | | | 0.30 | |
| Nutrient | | 0.18 | | | 0.52 | | 0.07 | | | 0.19 | | 0.09 | | | 0.26 | |
| G × S | | 0.32 | | | NS | | 0.12 | | | NS | | 0.20 | | | NS | |
| G × F | | 0.26 | | | NS | | 0.10 | | | NS | | 0.13 | | | NS | |
| S × F | | 0.36 | | | NS | | 0.14 | | | NS | | 0.19 | | | NS | |
| G × S × F | | 0.51 | | | NS | | 0.19 | | | NS | | 0.26 | | | NS | |

$G_1$ – DCH-177 $S_1$ – 90 cm x 60 cm with spacing $F_1$ – 100% RDF with sulphur

$G_2$ – DCH-519 $S_2$ – 90 cm x 60 cm without nipping $F_2$ – 100% RDF without sulphur

$S_3$ – 120 cm x 60 cm with nipping $F_3$ – 75% RDF with sulphur

$S_4$ – 120 cm x 60 cm without nipping $F_4$ – 75% RDF without sulphur

### Table 2: Total number of productive spikes plant$^{-1}$, number of capsules spike$^{-1}$ and bean yield of castor genotypes as influenced by spacing with nipping practices and nutrition

| G x S x F | | Total number of productive spikes per plant | | | | | Number of capsules spike$^{-1}$ | | | | | Bean yield (kg ha$^{-1}$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S |
| $G_1$ | $S_1$ | 6.64 | 6.49 | 5.73 | 5.55 | 6.10 | 38.17 | 37.58 | 35.21 | 34.70 | 36.41 | 1742 | 1727 | 1620 | 1600 | 1672 |
| | $S_2$ | 10.21 | 10.05 | 9.29 | 9.09 | 9.66 | 28.17 | 27.73 | 25.50 | 25.00 | 26.60 | 1149 | 1134 | 1028 | 1016 | 1081 |
| | $S_3$ | 8.48 | 8.19 | 7.50 | 7.33 | 7.87 | 42.84 | 42.49 | 40.48 | 40.05 | 41.47 | 1458 | 1433 | 1294 | 1278 | 1366 |
| | $S_4$ | 11.28 | 11.09 | 10.66 | 10.60 | 10.90 | 32.99 | 32.44 | 30.29 | 29.42 | 31.29 | 932 | 916 | 828 | 812 | 872 |
| $G_2$ | $S_1$ | 6.99 | 6.84 | 6.24 | 6.09 | 6.53 | 39.05 | 38.78 | 36.35 | 35.99 | 37.54 | 1823 | 1800 | 1656 | 1632 | 1728 |
| | $S_2$ | 10.45 | 10.37 | 9.72 | 9.58 | 10.03 | 29.21 | 28.83 | 26.83 | 26.60 | 27.87 | 1217 | 1200 | 1098 | 1082 | 1149 |
| | $S_3$ | 8.87 | 8.80 | 7.89 | 7.74 | 8.32 | 44.30 | 43.73 | 41.63 | 41.28 | 42.73 | 1536 | 1517 | 1359 | 1333 | 1436 |
| | $S_4$ | 11.74 | 11.63 | 10.98 | 10.85 | 11.29 | 34.42 | 33.95 | 31.66 | 31.44 | 32.87 | 988 | 969 | 889 | 867 | 928 |
| F | | 9.33 | 9.18 | 8.50 | 8.35 | | 36.14 | 35.69 | 33.49 | 33.06 | | 1356 | 1337 | 1221 | 1202 | |
| | | G x F | | | | G | G x F | | | | G | G x F | | | | G |
| $G_1$ | | 9.16 | 8.96 | 8.30 | 8.14 | 8.63 | 35.54 | 35.06 | 32.87 | 32.29 | 33.94 | 1320 | 1302 | 1192 | 1176 | 1248 |
| $G_2$ | | 9.51 | 9.41 | 8.71 | 8.56 | 9.04 | 36.75 | 36.32 | 34.11 | 33.83 | 35.25 | 1391 | 1371 | 1250 | 1228 | 1311 |
| | | S x F | | | | S | S x F | | | | S | S x F | | | | S |
| $S_1$ | | 6.81 | 6.66 | 5.98 | 5.82 | 6.32 | 38.61 | 38.18 | 35.78 | 35.35 | 36.98 | 1783 | 1764 | 1638 | 1616 | 1700 |
| $S_2$ | | 10.33 | 10.21 | 9.50 | 9.33 | 9.84 | 28.69 | 28.28 | 26.16 | 25.80 | 27.23 | 1183 | 1167 | 1063 | 1049 | 1115 |
| $S_3$ | | 8.67 | 8.49 | 7.69 | 7.53 | 8.10 | 43.57 | 43.11 | 41.05 | 40.67 | 42.10 | 1497 | 1475 | 1326 | 1305 | 1401 |
| $S_4$ | | 11.51 | 11.36 | 10.82 | 10.72 | 11.11 | 33.71 | 33.20 | 30.97 | 30.43 | 32.08 | 960 | 943 | 859 | 840 | 900 |

| Interactions | S.Em.± | C.D. (0.05) | S.Em. ± | C.D. (0.05) | S.Em. ± | C.D. (0.05) |
|---|---|---|---|---|---|---|
| Genotype | 0.03 | 0.19 | 0.05 | 0.29 | 6 | 32 |
| Spacing | 0.08 | 0.25 | 0.32 | 0.98 | 7 | 20 |
| Nutrient | 0.11 | 0.32 | 0.25 | 0.70 | 6 | 15 |
| G × S | 0.12 | NS | 0.45 | NS | 12 | NS |
| G × F | 0.16 | NS | 0.35 | NS | 8 | NS |
| S × F | 0.22 | NS | 0.49 | NS | 11 | 30 |
| G × S × F | 0.31 | NS | 0.69 | NS | 15 | NS |

$G_1$ – DCH-177 $S_1$ – 90 cm x 60 cm with spacing $F_1$ – 100% RDF with sulphur
$G_2$ – DCH-519 $S_2$ – 90 cm x 60 cm without nipping $F_2$ – 100% RDF without sulphur
$S_3$ – 120 cm x 60 cm with nipping $F_3$ – 75% RDF with sulphur
$S_4$ – 120 cm x 60 cm without nipping $F_4$ – 75% RDF without sulphur

### Table 2: Gross returns, net returns and BC ratio of castor genotypes as influenced by spacing with nipping practices and nutrition

| G x S x F | | Gross returns (₹ ha$^{-1}$) | | | | | Net returns (₹ ha$^{-1}$) | | | | | BC ratio | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S | $F_1$ | $F_2$ | $F_3$ | $F_4$ | G x S |
| $G_1$ | $S_1$ | 50501 | 50066 | 46964 | 46384 | 48479 | 32561 | 32501 | 29762 | 29557 | 31095 | 2.81 | 2.85 | 2.73 | 2.76 | 2.79 |
| | $S_2$ | 33310 | 32860 | 29787 | 29439 | 31349 | 15970 | 15895 | 13185 | 13212 | 14566 | 1.92 | 1.94 | 1.79 | 1.81 | 1.87 |
| | $S_3$ | 42267 | 41528 | 37513 | 37035 | 39586 | 24677 | 24313 | 20661 | 20558 | 22552 | 2.40 | 2.41 | 2.23 | 2.25 | 2.32 |
| | $S_4$ | 27019 | 26555 | 24004 | 23540 | 25279 | 10029 | 9940 | 7752 | 7663 | 8846 | 1.59 | 1.60 | 1.48 | 1.48 | 1.54 |
| $G_2$ | $S_1$ | 52849 | 52192 | 48007 | 47297 | 50086 | 34909 | 34627 | 30805 | 30470 | 32703 | 2.95 | 2.97 | 2.79 | 2.81 | 2.88 |
| | $S_2$ | 35281 | 34788 | 31817 | 31367 | 33313 | 17941 | 17823 | 15215 | 15140 | 16530 | 2.03 | 2.05 | 1.92 | 1.93 | 1.98 |
| | $S_3$ | 44514 | 43963 | 39383 | 38629 | 41622 | 26924 | 26748 | 22531 | 22152 | 24589 | 2.53 | 2.55 | 2.34 | 2.34 | 2.44 |
| | $S_4$ | 28628 | 28091 | 25772 | 25134 | 26906 | 11638 | 11476 | 9520 | 9257 | 10473 | 1.68 | 1.69 | 1.59 | 1.58 | 1.64 |
| F | | 39296 | 38755 | 35406 | 34853 | | 21831 | 21665 | 18679 | 18501 | | 2.49 | 2.53 | 2.39 | 2.43 | |
| | | G x F | | | | G | G x F | | | | G | G x F | | | | G |
| $G_1$ | | 38274 | 37752 | 34567 | 34099 | 36173 | 20809 | 20662 | 17840 | 17747 | 19265 | 2.18 | 2.20 | 2.06 | 2.08 | 2.13 |
| $G_2$ | | 40318 | 39759 | 36245 | 35607 | 37982 | 22853 | 22669 | 19518 | 19255 | 21074 | 2.30 | 2.32 | 2.16 | 2.17 | 2.24 |
| | | S x F | | | | S | S x F | | | | S | S x F | | | | S |
| $S_1$ | | 51675 | 51129 | 47486 | 46841 | 49282 | 33735 | 33564 | 30284 | 30014 | 31899 | 2.88 | 2.91 | 2.76 | 2.78 | 2.83 |
| $S_2$ | | 34295 | 33824 | 30802 | 30403 | 32331 | 16955 | 16859 | 14200 | 14176 | 15548 | 1.98 | 1.99 | 1.86 | 1.87 | 1.93 |
| $S_3$ | | 43391 | 42746 | 38448 | 37832 | 40604 | 25801 | 25531 | 21596 | 21355 | 23571 | 2.47 | 2.48 | 2.28 | 2.30 | 2.38 |
| $S_4$ | | 27823 | 27323 | 24888 | 24337 | 26093 | 10833 | 10708 | 8636 | 8460 | 9659 | 1.64 | 1.64 | 1.53 | 1.53 | 1.59 |

| Interactions | S.Em.± | C.D. (0.05) | S.Em. ± | C.D. (0.05) | S.Em. ± | C.D. (0.05) |
|---|---|---|---|---|---|---|
| Genotype | 57 | 346 | 57 | 346 | 0.01 | 0.02 |
| Spacing | 132 | 405 | 132 | 405 | 0.01 | 0.02 |
| Nutrient | 108 | 308 | 108 | 308 | 0.01 | 0.02 |
| G × S | 203 | NS | 203 | NS | 0.01 | NS |
| G × F | 153 | NS | 153 | NS | 0.01 | NS |
| S × F | 217 | 617 | 217 | 617 | 0.01 | 0.04 |
| G × S × F | 307 | NS | 307 | NS | 0.02 | NS |

$G_1$ – DCH-177 $S_1$ – 90 cm x 60 cm with spacing $F_1$ – 100% RDF with sulphu
$G_2$ – DCH-519 $S_2$ – 90 cm x 60 cm without nipping $F_2$ – 100% RDF without sulphur
$S_3$ – 120 cm x 60 cm with nipping $F_3$ – 75% RDF with sulphur
$S_4$ – 120 cm x 60 cm without nipping $F_4$ – 75% RDF without sulphur

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