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# AGRONOMIC PERFORMANCE OF DWARF, SEMIDWARF, AND CONVENTIONAL HEIGHT SUNFLOWER HYBRIDS GROWN AT FIVE PLANT POPULATIONS UNDER RAINFED CONDITIONS

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SUMMARY

Field experiments were conducted at three North Dakota rainfed environments to compare the agronomic performance of early maturing dwarf and semidwarf sunflower *Helianthus annuus L.* hybrids with a conventional height and maturity hybrid. The study evaluated hybrid response to several plant populations.

No differences in seed yield were observed among hybrids, row spacings, or the hybrid x row spacing and hybrid x population interactions. Increasing plant population, within the limits tested in this study, decreased seed yield of all three hybrids. Achene oil concentration was influenced by environments and hybrids. As row spacing decreased achene oil concentration increased. Achene oil concentration increased as plant population, within the limits of this study, increased. Oil yield (kg ha$^{-1}$) was heavily influenced by seed yield and to a lesser extent by achene oil concentration. Lodging increased when the tallest hybrid was sown at a wide row spacing and high population.

In most instances the performance of all three plant types was similar despite major differences in phenological development and plant stature.

**Key words: Sunflower, plant population, dwarf sunflower, semidwarf sunflower, row spacing.**

## INTRODUCTION

Sunflower hybrids of varying heights and maturities are available for commercial production. The typical height of most conventional U.S. hybrids, grown under rainfed conditions, is between 1.5 and 2.1 m. Semidwarf hybrids grown under similar conditions are normally between 1.2 and 1.5 m tall. The number of leaves of both types are similar with the semidwarf having shorter internodes. The one commercially grown dwarf hybrid currently available to producers is slightly earlier in maturity, and has fewer leaves than most hybrids. This hybrid is typically between 0.8 and 1.2 m tall.

Several advantages to reduced height sunflower have been suggested, including increased resistance to lodging (Berger, 1984; Herring, 1985). This response is the result of increased stalk strength and the shorter plant stature. These traits are particularly important in areas where strong winds can cause lodging (Moutous, 1982; Brigham and Young, 1985) or when sunflower is grown under irrigation. Tolerance to stalk weakening

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insects such as the stem weevils (*Cylindrocopturus adspersus* LeC. and *Apion occidentale* Fall), and increased ease of harvest have been reported as advantages of shorter plant types (Bye, 1985).

Results comparing yield performance of the different types have been variable. Brigham and Young (1985) reported lower yield from a semidwarf hybrid than from a conventional height hybrid. Schneiter et al. (1984) reported that, averaged across several populations, a semidwarf hybrid outyielded a conventional height hybrid of similar maturity by 4.6%. Majid and Schneiter (1987) reported that the highest seed yield for both plant types was obtained at a plant population of 32 000 plants $ha^{-1}$. Herring (1985) reported that reduced height hybrids produced high yields in South Africa and suggested they might perform especially well at high plant populations.

At a constant plant population, changes in row spacing influence the spatial distribution of plants in the field. Different combinations of plant population and row spacing result in rectangularities (distances between rows divided by distances between plants within rows) from 1, an equidistant arrangement, to extreme rectangularities. Holliday (1963) suggested that a square instead of a rectangular plant arrangement would improve resource utilization efficiency. In most crops extreme rectangularity is detrimental to yield. Robinson (1978) suggested that sunflower should produce their highest yields when inter and intra-row plant spacings are equal. At these arrangements the plant leaf canopy produces earlier and more complete soil coverage allowing greater light interception.

The objectives of this study were to determine the best combinations of row spacing and plant population for optimum seed production of dwarf, semidwarf, and conventional height sunflower hybrids.

## MATERIALS AND METHODS

Three sunflower hybrids, 'Ex 47' (Sigco Research, Breckenridge, Minnesota) an early semidwarf, 'Sunwheat 101' (Seedtec Int., Moorhead, Minnesota) an early dwarf, and the mid-season conventional height hybrid 'USDA 894' were grown under rainfed environments at Carrington, Prosper, and Langdon, North Dakota, during the 1988 growing season. The soil at Carrington, in central North Dakota, is a mixture of Heimdal (coarse-loamy, mixed Udic Haplaboroll) and Emrick (coarse-loamy, mixed Pachic Udic Haplaboroll). Soils at Prosper, in east central North Dakota, are mostly Perella (fine-silty, frigid, mixed Typic Haplaquoll) and Bearden (fine-silty, frigid, mixed Aeric Calciaquoll). The soil type at Langdon, in extreme north central North Dakota, is a Hamerly (fine-loamy, frigid, Aeric Calciaqoull).

Hybrids were sown in rows spaced 0.76, 0.45, and 0.30 m apart at plant populations of 45 000, 65 000, 85 000, 105 000, and 125 000 plants $ha^{-1}$. Two and one-half times the desired population was sown and thinned to the desired plant population at stage V2 (Schneiter and Miller, 1981). Weeds were controlled using trifluralin (a, a, a, trifluoro - 2, 6 - dinitro - N, N - dipropyl - p - toluidine) preplant incorporated at 0.84 kg (a.i.) $ha^{-1}$. This was supplemented by hand weeding, when necessary.

Experimental design was a randomized complete block in a split-split plot arrangement replicated four times. Hybrids were the main plot, while row spacings were the subplots. Populations were randomized within the subplots. Hybrids and row-spacing arrangements were randomized for each replication. Subplots consisted of 12 rows (3.6 m x 6.0 m), 8 rows (3.6 m x 6.0 m) and 6 rows (4.6 m x 6.0 m) for rows spaced 0.30, 0.45, and 0.76 m apart, respectively. Whole plots (hybrids) were bordered to remove competition effects among hybrids.

An area 5 $m^2$ from each plot was hand harvested for yield. The heads were dried, threshed and the seed cleaned and weighed. Achene oil concentration was determined using nuclear magnetic resonance. Values were expressed on a dry weight basis. Oil yield was determined by multiplying achene yield x achene oil concentration. Lodging was estimated as the percentage of plants that were bent or broken over.

For the analysis of variance, locations were termed environments. Environments were considered as random effects while hybrids, row spacings, and plant populations were considered fixed effects. Least significant differences were performed according to the procedure of Carmer et al., 1989.

## RESULTS AND DISCUSSION

### Climatological Conditions

Precipitation during the 1988 growing season was below normal while temperatures were above normal (Table 1). These trends occurred at all three locations. Differences in rainfall distribution during the growing season at each location influenced the response of most characters evaluated in the study.

### Seed Yield

Seed yields at each location were slightly below long term averages. Environment had a significant influence on seed yield (Table 2). Seed yields were significantly higher ($P<0.01$) at Langdon than at either Prosper or Carrington, which were not significantly different from each other (Table 3). This response reflected differences among locations in soil moisture, soil texture, soil fertility, precipitation pattern, and temperature.

No differences in seed yield were found among hybrids. Similar results comparing conventional height and semidwarf hybrids have been reported by Zaffaroni and Schneiter (1985), Majid and Schneiter (1987, 1988), and Schneiter et al. (1988). Averaged across environments, row spacing did not influence seed yield. A similar response has been reported by several researchers (Vijayalakshmi et al., 1975, Robinson et al., 1982, Silva and Schmidt, 1985, and Schneiter and Zaffaroni, 1987). Radford (1978) and Gubbels and Dedio (1986) reported increased seed yield with narrower row spacings.

Significant differences ($P<0.01$) in seed yield were found due to plant population and the hybrid x environment, row spacing x environment, and hybrid x row spacing x environment interactions.

The significance of the hybrid x environment interaction indicates that the hybrids responded differently to the environments (Table 3). The different responses are most likely related to the availability of soil moisture at critical periods of crop growth. The critical water supply period for sunflower seed production occurs between 20 days before and 20 days after anthesis (Robinson, 1978). At Prosper days from planting to R5.1 and R9 (maturity) respectively averaged 71, 61, 63 and 117, 98, and 106 days, for USDA 894,

Table 1. Temperature, precipitation and departure from average from May through August, 1988 at Prosper, Carrington, and Langdon, ND.

| Location | Temperature | | Precipitation | |
|---|---|---|---|---|
| | Mean | departure | Total | departure |
| | °C | | mm | |
| Prosper | | | | |
| May | 17.5 | +4.3 | 30 | -56 |
| June | 23.4 | +4.8 | 33 | -45 |
| July | 29.3 | +2.7 | 8 | -77 |
| August | 21.6 | +1.0 | 61 | -7 |
| Carrington | | | | |
| May | 15.9 | +4.7 | 29 | -35 |
| June | 22.6 | +5.9 | 58 | -38 |
| July | 22.4 | +2.4 | 22 | -43 |
| August | 19.9 | +0.6 | 58 | +4 |
| Langdon | | | | |
| May | 14.6 | +3.8 | 25 | -29 |
| June | 21.6 | +5.5 | 13 | -65 |
| July | 20.3 | +1.2 | 60 | -10 |
| August | 19.3 | +1.4 | 31 | -37 |

Table 2. Analysis of variance for seed yield, achene oil concentration, and oil yield as influenced by sunflower hybrid, row spacing, plant population, and environment.

| Sources of variation | Seed yield | Achene oil concentration | Oil yield |
|---|---|---|---|
| Environment (E) | ** | ** | ** |
| Hybrid (H) | NS | ** | NS |
| H x E | ** | * | ** |
| Row spacing (S) | NS | ** | * |
| S x E | ** | NS | ** |
| H x S | NS | NS | NS |
| H x S x E | ** | NS | * |
| Population (P) | ** | ** | ** |
| P x E | NS | NS | * |
| H x P | NS | NS | * |
| H x P x E | NS | NS | NS |
| S x P | NS | NS | NS |
| S x P x E | NS | NS | NS |
| H x S x P | NS | NS | NS |
| H x S x P x E | NS | NS | NS |
| C.V. (%) | 15.8 | 2.8 | 16.5 |

*, **, NS: Significant at the 0.05 and 0.01 probability levels, and not significant, respectively.

Ex 47, and Sunwheat 101, respectively. Rainfall timing and amounts varied among environments (Table 1). As a result water stress occurred at different stages for each hybrid at each environment. At Carrington most of the moisture deficits occurred during and after anthesis while at Langdon the moisture deficit was most critical just before anthesis. At Prosper available moisture was limited the entire growing season.

The row spacing x environment interaction was statistically significant at $P<0.05$. Sunflower grown in rows spaced 0.30 m and 0.45 m apart outyielded those in rows spaced 0.76 m apart at both Prosper and Langdon (Table 4). Differences in seed yield due to row spacing were not observed at Carrington, although a trend toward increased yield with decreased row spacing was evident.

The hybrid x row spacing x environment interaction was significant (Table 4). Hybrids responded differently to row spacing at Prosper than at Langdon (Table 4). At Prosper USDA 894 grown in rows spaced 0.45 m apart yielded higher than when grown in rows spaced either 0.30 or 0.76 m apart. Ex 47 and Sunwheat 101 grown at Prosper tended toward higher seed yields in the two more narrow row spacings. Yield trends of USDA 894 at Langdon were similar to those at Prosper. Achene yields of Wx 47 grown in rows spaced 0.30 and 0.45 m apart were similar and greater than the 0.76 m row spacing. Yield of Sunwheat 101 grown at Langdon in rows spaced 0.45 m apart was statistically greater than from the other row spacings. Yields from all row spacings from each hybrid were similar at Carrington. As previously indicated, Radford (1978) and Gubbels and Dedio (1986) reported increased sunflower seed yield with more narrow row spacing. The spatial distribution of plants growing in narrower row spacing would be more square. This would allow earlier and more complete soil coverage by the plant leaf canopy and increased light interception (Holliday, 1963 and Robinson, 1978). Environmental stress factors can modify these potential advantages.

The regression of seed yield against plant population resulted in a significant negative linear relationship (Figure 1). A wide range of plant populations have been reported for optimum seed yield production (Vijayalakshmi et al., 1975 and Robinson et al., 1980). Implications of previous research are that optimum density is determined by genotype, climatic conditions and soil fertility. Jessop (1977), reported that as plant population increased, the competition for water and nutrients becomes more critical and can decrease yield. The drought conditions at which this study were conducted, coupled with increased competition at the higher plant densities for a limited supply of soil moisture, decreased seed yield. The recommended plant population for commercial sunflower production in the northern Great Plains is 45 000 plants $ha^{-1}$. None of the interactions involving plant population were significant.

**Achene Oil Concentration**

Achene oil concentration was influenced by environments, hybrids, row spacings, populations, and by the interaction of hybrids and environments (Table 2). Oil concentrations of the achenes were significantly higher at Prosper and Langdon than at Carrington (Table 5). Averaged across environments, Ex 47 and Sunwheat 101 had similar and significantly lower achene oil concentrations than USDA 894. The higher achene oil concentration of USDA 894 will result in increased economic benefit as producers are paid a price bonus for production of achenes with high oil content.

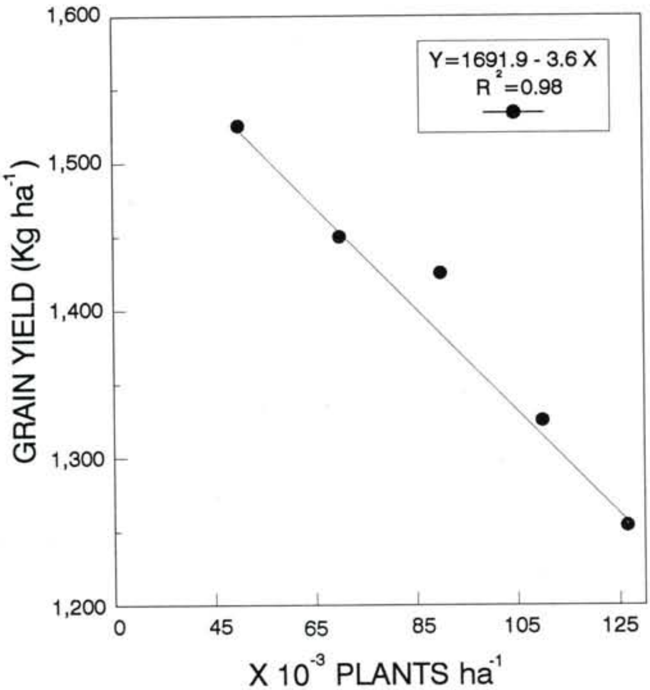


*Figure 1 Plant population effect on sunflower seed yield, averaged across hybrids, row spacings, and environments.*

Achene oil concentration of the different hybrids was strongly influenced by environment. At all three environments, hybrids were ranked in the same order for achene oil concentration. USDA 894 produced the highest achene oil concentration at each environment. The achene oil concentrations of Ex 47 and Sunwheat 101 were similar. At Carrington and Langdon, the achene oil concentration of Sunweat 101 was significantly higher than that of Ex 47.

Harris et al. (1978) reported achene oil concentration decreases with increasing maximum day temperature. Other environmental factors including moisture stress influence seed size and the hull to kernel ratio, which both influence achene oil concentration. Above normal temperatures and differing rainfall patterns at each environment may account for the differences observed in achene oil concentrations. Genetic potential is also a major factor influencing achene oil concentration.

Row spacing had a significant effect on achene oil concentration with values of 436, 433, 430 g $kg^{-1}$ for 0.30, 0.45 and 0.76 m row spacings, respectively. A significant negative linear regression ($Y = 43.888 - 0.011X, R^2 = 0.96$) existed when oil content was regressed against row spacing. Higher achene oil concentrations at 0.45 m compared with 0.90 m row spacing were reported by Gubbels and Dedio (1986). They suggested that the reason for the improved performance at the narrower row spacing may have been greater light interception from a more equidistant plant distribution at the early stages of plant development. The higher achene oil concentrations in our study from the different row spacings were relatively insignificant since the difference was only 6 g $kg^{-1}$.

Table 3. Mean seed yield of three sunflower hybrids grown at three environments, averaged across three row spacings and five plant population.

| Hybrid | Environment | | | Mean |
|---|---|---|---|---|
| | Prosper | Carrington | Langdon | |
| | kg ha$^{-1}$ | | | |
| USDA 894 | 1450 | 930 | 1780 | 1390 |
| Ex 47 | 1130 | 1160 | 1500 | 1260 |
| Sunwheat 101 | 1180 | 1370 | 1940 | 1500 |
| Mean | 1250 | 1160 | 1740 | |
| LSD (0.05) | Environment = 320<br>Hybrid = not significant<br>Environment x hybrid = 120 | | | |

Table 4. Mean seed yield of three sunflower hybrids grown at three row spacings and three environments averaged across five plant populations.

| Hybrid | Row spacing | Environment | | |
|---|---|---|---|---|
| | | Prosper | Carrington | Langdon |
| | m | kg ha$^{-1}$ | | |
| USDA 894 | 0.30 | 1480 | 930 | 1790 |
| | 0.45 | 1620 | 940 | 1860 |
| | 0.76 | 1260 | 930 | 1700 |
| Ex 47 | 0.30 | 1140 | 1200 | 1660 |
| | 0.45 | 1190 | 1180 | 1600 |
| | 0.76 | 1050 | 1110 | 1240 |
| Sunwheat 101 | 0.30 | 1230 | 1430 | 1910 |
| | 0.45 | 1200 | 1360 | 2110 |
| | 0.76 | 1110 | 1320 | 1790 |
| LSD (0.05) Environment x hybrid x row spacing = 140 | | | | |
| | 0.30 | 1280 | 1190 | 1790 |
| | 0.45 | 1340 | 1160 | 1860 |
| | 0.76 | 1140 | 1120 | 1580 |
| LSD (0.05) Environment x row spacing = 80 | | | | |

Table 5. Mean achene oil concentration (dry weight basis) of three sunflower hybrids grown at three environments, averaged across three row spacings and five populations.

| Hybrid | Environment | | | Mean |
|---|---|---|---|---|
| | Prosper | Carrington | Langdon | |
| | g kg$^{-1}$ | | | |
| USDA 894 | 489 | 453 | 472 | 471 |
| Ex 47 | 427 | 381 | 414 | 407 |
| Sunwheat 101 | 428 | 403 | 432 | 421 |
| Mean | 448 | 412 | 439, | |
| LSD (0.05) | Environment = 9<br>Hybrid = 16<br>Hybrid x environment = 10 | | | |

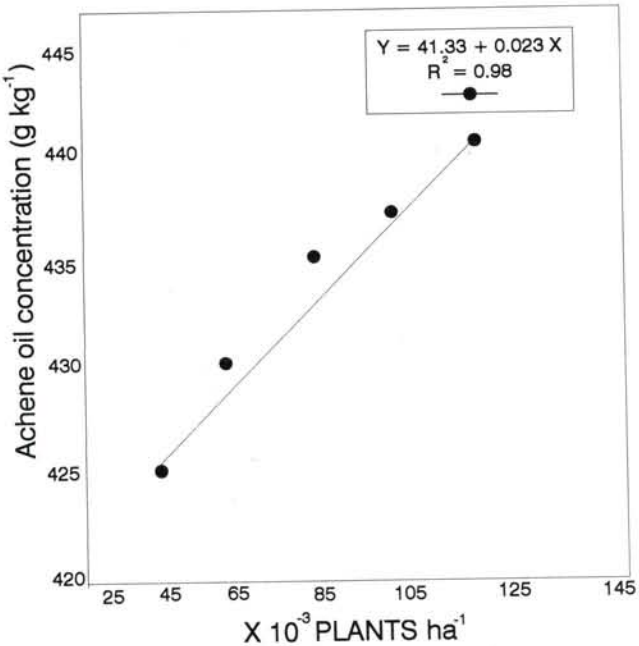


*Figure 2 Plant population effect on sunflower achene oil concentration, averaged across hybrids, row spacings, and environments.*

The relationship between achene oil concentration and plant population within the limits of this study was significant (Figure 2). Decreasing oil concentration with decreasing plant population is a common response. One would expect achene oil concentration to begin to decrease at extremely high plant populations.

Several significant differences for oil yield were found. Environment and plant population had a significant ($P<0.01$) effect on oil yield. The hybrid x environment and row spacing x environment interactions were significant at the $P<0.01$ level, while row spacing, and the hybrid x row spacing x environment, population x environment, and hybrid x population interactions were significant at $P<0.05$ (Table 2). Hybrids effects were non-significant.

Oil yield is the product of seed yield and achene oil concentration. High oil yields at Langdon were the result of high seed yields at that location (Table 3). A tendency toward greater oil yield with more narrow row spacings was observed at Prosper and Langdon but not at Carrington (Table 6). Averaged across hybrids and environments, production in rows spaced 0.30, 0.45, and 0.76 m apart produced oil yields of 620, 630, and 551, respectively, with an LSD $P<0.5$ of 63 kg $ha^{-1}$.

The hybrid x population interaction was significant for oil yield (Table 2). USDA 894 grown at 45 000 plants $ha^{-1}$ produced a higher oil yield than the other hybrids at any plant population (Table 7). The high oil yield is a consequence of the high seed yield at the lowest plant population coupled with high achene oil concentration. A tendency of

Table 6. Sunflower oil yield as influenced by hybrid, row spacing and environment averaged across five plant populations.

| | | Environment | | |
|---|---|---|---|---|
| Hybrid | Row spacing | Prosper | Carrington | Langdon |
| | m | | kg ha$^{-1}$ | |
| USDA 894 | 0.30 | 728 | 423 | 846 |
| | 0.45 | 779 | 424 | 874 |
| | 0.76 | 613 | 419 | 800 |
| Ex 47 | 0.30 | 491 | 465 | 691 |
| | 0.45 | 513 | 448 | 666 |
| | 0.76 | 435 | 419 | 513 |
| Sunwheat 101 | 0.30 | 526 | 579 | 835 |
| | 0.45 | 516 | 545 | 908 |
| | 0.76 | 468 | 530 | 770 |
| LSD (0.05) | Environment x hybrid (H) x row spasing (S)<br>Same level of H, different (Dif.) level of S = 71<br>Dif. level of H, same level of S = 176<br>Dif. level of H, dif. level of S = 181 | | | |
| Hybrid | | | | |
| USDA 894 | | 707 | 422 | 840 |
| Ex 47 | | 480 | 444 | 623 |
| Sunwheat 101 | | 503 | 551 | 838 |
| Mean | | 563 | 472 | 767 |
| LSD (0.05) | Environment = 140<br>Environment x hybrid = 50 | | | |

Table 7. Mean oil yield of three sunflower hybrids grown at five plant populations averaged across three row spacings and three environments.

| Hybrid | Plant population | Oil yield |
|---|---|---|
| | plant ha$^{-1}$ | kg ha$^{-1}$ |
| USDA 894 | 45 000 | 753 |
| | 65 000 | 687 |
| | 85 000 | 682 |
| | 105 000 | 594 |
| | 125 000 | 566 |
| Ex 47 | 45 000 | 553 |
| | 65 000 | 537 |
| | 85 000 | 536 |
| | 105 000 | 486 |
| | 125 000 | 467 |
| Sunwheat 101 | 45 000 | 642 |
| | 65 000 | 644 |
| | 85 000 | 623 |
| | 105 000 | 642 |
| | 125 000 | 604 |
| LSD (0.05) | Hybrid (H) x plant population (P)<br>Same level of H, different (Dif.) level of P = 68<br>Dif. level of H, same level of P = 177<br>Dif. level of H, dif. level of P = 179 | |

higher oil yield for Ex 47 was observed in the lowest population. Plant population did not have a significant effect on the oil yield of Sunwheat 101.

### Plant Lodging

One of the reported advantages for reduced height sunflower is increased lodging resistance. Because of the dry environmental conditions, plant heights of all three hybrids were reduced and lodging was limited. Lodging percentages ranged between 0 and 3% at Prosper and 0 and 4% at Langdon. At Carrington, similar lodging values were observed for most treatments (approximately 1 - 4%), except where USDA 894 was grown at 0.76 m row spacing at the two highest plant populations. Lodging in those treatments was 12 and 22% for 105 000 and 125 000 plants $ha^{-1}$, respectively. Growing conditions early in the season, at Carrington were more favorable for plant development than at the other two locations. This was evident by an increased amount of vegetative growth. At a constant plant population, plants in the row become closer as row spacings became wider. As a result, competition for sunlight may be a factor, resulting in the development of taller plants with thinner stems. Under these conditions, stalks of USDA 894, the tallest hybrid, would probably be weaker than those of either Ex 47 or Sunwheat 101 and more subject to lodging.

## CONCLUSIONS

Seed yields were similar among hybrids and row spacings. The hybrid x row spacing and hybrid x population interactions were not significant. Significant yield differences were found due to environment, plant population, and the hybrid x environment and row spacing x environment interactions. Average seed yields were 1740, 1250, and 1160 kg $ha^{-1}$ at Langdon, Prosper, and Carrington, respectively. USDA 894 produced the highest seed yield at Prosper, while Sunwheat 101 outyielded the other two hybrids at Carrington and Langdon. A trend toward increased yield with decreased row spacing was evident at all environments but statistically significant only at Prosper and Carrington. Seed yield of all hybrids, decreased with increasing plant density within the population ranges tested.

Achene oil concentration was significantly influenced by environments and hybrids. The highest achene oil concentrations were produced at Prosper and Langdon. USDA 894 had a higher oil concentration (471 g $kg^{-1}$) than either Sunwheat 101 (421 g $kg^{-1}$) or Ex 47 (407 g $kg^{-1}$) which were not different from each other. Seed oil concentration increased as row spacing decreased and plant population increased.

The slightly higher achene oil concentration of USDA 894 was not reflected as higher oil yield, as no differences were detected among hybrids. Most patterns in oil yield were closely related to those observed with seed yield.

At the higher plant populations the shorter statured hybrids, EX 47 ans SW 101, had lower levels of plant lodging tha the taller hybrid USDA 894.

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**COMPORTAMIENTO AGRONOMICO DE HIBRIDOS DE GIRASOL ENANO, SEMI-ENANOS Y ALTURA CONVENCIONAL CULTIVADOS A CINCO DENSIDADES DE PLANTAS BAJO CONDICIONES DE SECANO**


RESUMEN

Los experimentos del campo fueron conducidos en tres ambientes de secano de North Dacota para comparar el comportamiento agronómico de hibridos de girasol (*Helianthus annuus* L.) tempranos, enanos y semienanos con un hibrido convencional en altura y ciclo. El estudio evaluó la respuesta de los hibridos evaluados a varias densidades.

No se observaron diferencias en rendimento entre hibridos, distancia entre hileras en les interacción hibrido x distancia entre hileras e hibrido x densidad. El incrementó del número de plantas dentro de los limites ensayados en este estudio desminuyó el rendimento de los tres hibridos. La concentración del aceite de los aquenios estuvo influenciada por ambientes e hibridos. Al desminuir las distancia entre hileras se incrementó el contenido de aceite. El conteido de aceite incrementó con la densidad de plantas dentro de los limites de este estudio. El rendimiento del aceite (kg/ha) fue altamente influenciado por el rendimiento de la semilla y en menor extensión por el contenido de aceite del aquenio. El encamado se incrementó cuando los hibridos más altos fueron sembrados a un espaciamiento más amplio y alta densidad. En la mayoria de los casos el comportamiento de los tres tipos de plantas fue similar a posar las mayores diferencias en desarrollo fenológico y estatura de las plantas.


**ETUDE DES PERFORMANCES AGRONOMIQUES D'HYBRIDES DE TOURNESOL NAINS, DEMI-NAINS ET DE TAILLE NORMALE EN FONCTION DE CINQ STRUCTURE DE POPULATION**


RÉSUMÉ

Des expérimentations en champ ont été conduites dans trois localités du Nord Dakota afin de comparer les performences agronomiques d'hybrides de tournesols précoces nains et demi-nains avec un hybrides de précocité et de taille conventionnelles. L'étude a évalué la résponse des hybrides à plusieurs structures de population.

Aucune différence au niveau du rendement en grain n'est apparue entre les hybrides, l'espacement entre rangs ou du au fait de l'interaction hybrides x espace entre rangset hybrides x structure de population. Augmenter la densité de population, dans les limites testées dans cette étude, a provoqué une diminution du rendement des trois hybrides. Le teneur en huile est dépendante de l'environement et des hybrides. Diminuer l'espace entre rangs ou augmenter la densité de population a provoqué un acroissement de la teneurs en huile toujours dans les limites de notre étude. Le rendement en huile (en kg/ha) était fortement influencé par le rendement en grain et dans une moindre mesure par la teneur en huile. Le nombre d' achènes par capitule augmente quand le plus haut des hybrides a été semé avec un espace entre rang imortant et une densité de population élevée.

Dans la plus part des cas la performance des trois types de plante était similaire malgré des différences très nettes dans le développement phénologique et la taille des plantes.