PERFORMANCE OF EARLY MATURING SUNFLOWER HYBRIDS UNDER DELAYED PLANTING CONDITIONS IN NORTH DAKOTA, USA

Hussain S. Wajid: Assistant Botanist (Economics), Agricultural Research Institute TARNAB, Peshawar,Pakistan.

Albert A. Schneiter: Professor Crops and Weed Science Department, North Dakota State University FARGO, ND58105 USA.

SUMMARY

Sunflower (Helianthus annuus L.) hybrids of differing plant type and maturity were sown at Prosper and Carrington, North Dakota, USA at approximately 15 d intervals beginning 1 June, 1988 and 1989. Plant populations of 50 000 and 75 000 plants ha^{-1} were evaluated. Plantings made on 15 July were not harvested, as none of the hybrids reached physiological maturity. Seed yield was highest on the 15 June planting date in both years of the study. 'USDA 894', a conventional height and maturity genotype, produced the greatest seed yield when planted on 1 June. 'Sunwheat 101', an early maturing dwarf hybrid, and 'EX-47', a semidwarf hybrid, produced significantly higher seed yield than USDA-894 on the 15 June and 30 June planting dates. Planting date had no effect on oil content of the hybrids. Highest seed yield, seed weight, and seeds $head^{-1}$ were obtained at 50 000 plants ha^{-1}. Population had no effect on the oil content of the hybrids. Test weight, was reduced at the later planting dates. The data suggests that USDA 894 should not be planted much later than 15 June, while the other two hybrids can be planted as late as 30 June.

INTRODUCTION

Sunflower production involves a series of decisions, and one of the most controversial is the optimum date of planting. Planting date affects not only sunflower growth, but it also affects the severity of damage from insect and fungi that feed on sunflower. Consequently, recommendations are often generalized to include a 1-2 month period in the northern states of USA (Robinson et al 1985).

Hybrids of three plant types are available for commercial production in the U.S.A. Height of these hybrids under most environmental conditions are: Conventional (1.5-2m), semidwarf (1.0-1.3 m), and dwarf (less than 1.0 m) (Schneiter's Personal Communication). The conventional types are most widely grown and semidwarf and dwarf types have only recently become available for cultivation(Hussain 1990).

Some of the dwarf and semidwarf types are extremely early maturing and could possibly be grown as a catch crop when replanting is necessary due to damage to an established crop or when planting is delayed. The performance of early maturing sunflower at delayed planting needs to be evaluated.

The average last spring frost occurs about 15 May in southeastern North Dakota and the end of May in small scattered areas in the northern part of the state. The first fall frost can usually be expected between 15-25 September over most of North Dakota (Jenson 1972).

The objectives of this study were:

1. To compare the effect of planting date on agronomic performance of selected early maturing dwarf and semi-dwarf sunflower hybrids with conventional height and medium maturing sunflowers.
2. To compare two plant densities of 50 000 and 75 000 plants ha^{-1} on the performance of three plant types as they interact with planting dates.

MATERIALS AND METHODS

Studies were conducted on dry land at Prosper and Carrington North Dakota, USA. Two early maturing hybrids, a dwarf 'sunwheat 101' and a semidwarf 'Ex-47', were planted in comparison with a conventional height and medium maturity standard hybrid 'USDA-894', at 15 d intervals from 1 June to 15 July 1988 and 1989. On each planting date, populations of 50 000 and 75 000 plants ha^{-1} were established by overseeding and then thinning to the desired population at the V2 stage (Schneiter and Miller, 1981).

Experimental plots consisted of 12 rows spaced 0.45 m and 6.2 m in length. Planting was done with a John Deere Model-71 flex planter. Weeds were controlled with a pre-plant application of trifluralin (α, α, α-trifluoro-2, 6-dintro-N, N-dipropyl-P-toluidine) at 0.75 kg ha^{-1}. Sites were tested for essential plant nutrients and fertilized for a yield goal of 2500 kg ha^{-1} according to recommendation by Dahnke et al (1990).

The following data were recorded on each plot:

1. Seed yield: Heads were harvested from a $5m^2$ area in the four central rows. Plant material was dried, threshed, and the seed was cleaned and weighed.
2. 1000 seed weight.
3. Number of seeds $head^{-1}$.

4. Oil percentage: Samples from the harvested seed were dried at 130°C in the oven for three hours to near 0% moisture and the oil content was determined using nuclear magnetic resonance (NMR).

5. Test weight: The weight of 0.47 L clean seed expressed as kgm^3.

The experimental design was a randomized complete block with a split, split plot arrangement. The planting dates constituted the main plots, hybrids the sub-plots and populations the sub-sub-plots. For analysis of variance, locations and years were combined and termed environments. Environments were treated as random effects, while the planting dates, hybrids, and plant populations were considered as fixed effects. For sources of variation, degrees of freedom, expected mean squares and F-ratios, a model as suggested by Carmer et al.(1989) was followed. LSD was calculated using a SAS program(1985).

RESULTS

Seed yield was significantly influenced by planting dates. The highest seed yield was obtained with the 15 June plantings (Table-1). USDA 894 produced the greatest seed yield on the 1 and 15 June plantings. The seed yield of USDA 894 decreased as planting was delayed till 30 June. Sunwheat 101 and Ex-47 produced the highest seed yield on the 15 June planting date. Delay in planting till 30 June significantly reduced their seed yield (Table-2).

Planting date had a significant effect on seed weight of the hybrids. Seed weight increased as the planting date was delayed beyond 1 June (Table-3). Environment x date x hybrid interaction was significant for seed weight (Table-4). Sunwheat 101 followed by Ex-47 produced the highest seed weight on all planting dates in all environments. Planting date x plant population interaction was significant for seed weight. Seed weight from 50 000 plants ha^{-1} increased as the seeding date was delayed till 15 and 30 June (Table-3).

The number of seeds $head^{-1}$ decreased with a delay in planting in the case of USDA 894. The other two hybrids were not significantly influenced by planting date for number of seeds $head^{-1}$ except that Ex-47 produced a higher number of seeds $head^{-1}$ on 15 June than 1 and 30 June plantings (Table-5).

The oil content of the hybrids was not influenced by delay in planting. However, environments x date x hybrid interaction was significant. The oil content of USDA 894 were similar on 1 and 15 June planting dates in 1988. However, it was higher at Prosper than at Carrington. In 1989, the oil content of USDA 894 was highest on 1 June but decreased on 15 and 30 June plantings at both locations. Sunwheat 101 and Ex-47 had an inconsistent response on the 1 and 15 June planting. The oil content of the hybrids, dropped significantly on the 30 June planting date in all environments (Table-6).

Test weights of the hybrids were influenced by delayed planting. Hybrids sown on 1 and 15 June had significantly higher test weights than on the 30 June plantings (Table-7).

DISCUSSION AND CONCLUSION

The three hybrid; USDA 894, Sunwheat 101 and Ex-47 differ in their height and maturity. USDA 894 is a conventional height and medium maturity genotype,

thus has produced higher seed yield when planted earlier. The other two hybrids are earlier maturing genotypes than USDA 894, thus have performed well even at later planting dates. The data indicated that early maturing genotypes could be sown up to 30 June while conventional height and maturity genotypes need to be sown before 15 June.

Planting date had a significant effect on seed weight (Table-3) which increased when planting was delayed beyond 1 June. This response may be due to seed maturation in cooler weather with the later plantings. The high seed yield which occurred on the 15 June planting is attributed to the high seed weight on this planting date. Because Sunwheat 101 and Ex-47 are earlier maturing genotypes than USDA 894, they produced heavier seeds, especially on the later planting dates. This also explains their higher yield when planted later. Possibly the hybrids with higher seed weight were the result of a greater sink potential which allowed the storage of higher amounts of assimilates in the seed (Majid 1986).

Planting date had a significant effect on the number of seeds head^{-1}. Averaged across hybrids, plantings on 1 and 15 June produced a significantly higher number of seeds head^{-1} than the 30 June planting (Table-5). The influence of number of seeds head^{-1}, a yield component, was reflected in higher grain yields on the 1 and 15 June planting dates. USDA 894 produced the greatest number of seeds head^{-1} on the 1 June planting (Table-5). The number of seeds head^{-1} of USDA 894 decreased as the planting was delayed. This phenomenon is clearly explained by the higher seed yield of USDA 894, on 1 June planting and the reason for the decrease in number of seeds head^{-1} with delayed planting may be the later maturity of the hybrid.

The planting date had no effect on the oil content of the hybrids. The hybrids showed an inconsistent response to seed oil content. Researchers have established several environmental factors that influence oil development in sunflower. Goyne et al (1979) reported that available soil water, disease level and mean temperature from planting to first anthesis are important factors influencing oil content. Majid (1986) suggested that a combination of unknown plant and environmental factors may be the reasons for different oil content levels in sunflower genotypes grown in different environments.

Delayed planting had a significant effect on test weight. Hybrids sown earlier had a higher test weight (Table-7). This would be expected as one would anticipate poorer seed development from plants sown at less optimum conditions.

Table-1. Mean seed yield, 1000 seed weight and seeds head^{-1} of three sunflower hybrids planted on three dates combined across environments, hybrids, and populations.

Planting date	Seed yield	1000 seed weight	Seeds head^{-1}
	kg ha^{-1}	g	
1 June	1617	35.4	736
15 June	1857	39.5	722
30 June	1289	38.9	588
15 July	--	--	--
LSD (0.05)	198	2.3	117

Table-2. Mean seed yield of three sunflower hybrids planted on three dates (15 July planting date is not included in the statistical analysis) averaged over environments and populations.

Planting dates	Hybrids		
	USDA 894	Sunwheat 101	Ex-47
	kg ha^{-1}		
1 June	1846	1759	1249
15 June	1673	2140	1757
30 June	837	1752	1277
15 July	--	66	14
Mean	1452	1883	1427

LSD (0.05) Date x Hyb = 373 kg ha^{-1}
Hybrids = N.S.

Table-3: Mean 1000 seed weight of three sunflower hybrids sown on three dates, two populations and combined across environments and hybrids.

Populations	Planting dates			
	1 June	15 June	30 June	Mean
Plants ha^{-1}	g			
50 000	37.0	43.2	41.0	40.4
75 000	33.7	35.8	36.9	35.5
Mean	35.4	39.5	38.0	

LSD (0.05) Dates x population = 1.5
Dates of Planting = 2.3
Population = 4.3

Table-4: Mean 1000 seed weight of three sunflower hybrids planted on three dates, four environments and averaged across two populations.

Environments	Dates of planting	Hybrids		
		USDA 894	Sunwheat 101	Ex-47
		g		
Prosper	1 June	30.8	44.3	35.1
1988	15 June	41.8	41.9	39.8
	30 June	36.5	52.3	41.2
Carrington	1 June	20.4	42.3	29.5
1988	15 June	30.8	42.2	32.9
	30 June	23.4	44.1	34.6
Prosper	1 June	34.3	46.2	38.9
1988	15 June	32.4	55.8	41.2
	30 June	35.7	50.7	39.0
Carrington	1 June	29.4	39.4	32.9
1988	15 June	30.5	49.0	36.4
	30 June	25.3	48.3	35.2

LSD (0.05) Env x date x hyb = 5.5
Hybrids = 3.2

Table-5 : Mean number of seeds head^{-1} of three sunflower hybrids planted on three dates, averaged across environments and populations.

Planting dates	Hybrids			Mean
	USDA 894	Sunwheat 101	Ex-47	
	seeds head^{-1}			
1 June	1008	650	548	735
15 June	794	661	710	722
30 June	603	597	564	588
Mean	802	636	608	

LSD (0.05) Date x hybrid = 184
Planting Date = 117
Hybrid = N.S

Table-6: Mean oil content (D.W. Basis) of three sunflower hybrids planted on three dates under four environments, and combined across populations.

Environments	Hybrids	Dates of Planting		
		1 June	15 June	30 June
		%		
Prosper 1988	USDA 894	54.4	54.4	49.6
	Sunwheat 101	49.3	48.9	49.7
	Ex-47	43.4	51.8	52.7
Carrington 1988	USDA 894	44.7	41.8	35.7
	Sunwheat 101	45.5	37.7	34.7
	Ex-47	39.7	42.3	37.1
Prosper 1989	USDA 894	49.8	45.4	41.4
	Sunwheat 101	45.6	45.6	40.4
	Ex-47	45.0	44.7	38.8
Carrington 1989	USDA 894	47.2	41.9	33.7
	Sunwheat 101	37.0	45.0	39.2
	Ex-47	37.8	45.0	38.7

LSD (0.05) Env x Dates x Hyb = 3.0

Table-7: Mean test weights of three sunflower hybrids planted on three dates under four environments, and combined across populations.

Environments	Hybrids	Dates of Planting		
		1 June	15 June	30 June
		kg m^{-3}		
Prosper 1988	USDA 894	396	414	298
	Sunwheat 101	370	375	336
	Ex-47	387	387	340
Carrington 1988	USDA 894	301	348	259
	Sunwheat 101	327	308	345
	Ex-47	308	302	328
Prosper 1989	USDA 894	417	370	301
	Sunwheat 101	424	443	345
	Ex-47	402	404	386
Carrington 1989	USDA 894	378	317	275
	Sunwheat 101	351	395	299
	Ex-47	330	369	309

LSD(0.05)Env x Dates x Hyb = 3.7
Planting date = 22

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