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EFFECT OF DESICCANT APPLICATION AND TIME OF HARVEST ON YIELD AND OIL QUALITY OF SUNFLOWER (*Helianthus annuus* L.)

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SUMMARY

A field study was conducted on four desiccants; Dimethipine, Metoxuron (Dosanex), Drop-leaf and Diaquat, during 1990 and 1991. Two rates of each desiccant were sprayed on sunflower (*Helianthus annuus* L.) hybrid NK-212 15 days after flower completion. Two harvesting dates (10 and 20 days) after desiccant application were superimposed on each desiccant treatment. The objective of this specific study was to determine the relative efficacy of different desiccants at two different rates, harvested on two different dates after application and their consequent effect on seed yield, oil quality and other agronomic characters of sunflower. As an average of the two years, desiccant treatment means were significantly different for all the traits studied. The lowest seed yields (1667 and 1674 kg/ha) were obtained from lower and higher doses of Diaquat, respectively. Conversely, higher yields were obtained by both rates of either Drop-leaf (2222 and 2342 kg/ha) or Metoxuron (2121 and 2168 kg/ha) as compared with the other treatments. Application of Diaquat and Dimethipine reduced the yield significantly as compared with the control, Drop-leaf and Metoxuron (Dosanex). Similarly, low and high oil contents were attributed to Diaquat and Drop treatments, respectively. This study concluded that Drop-leaf and Metoxuron (Dosanex) can be safely used as desiccants on sunflower at the rates of 0.225 and 0.750 kg ai/ha, respectively. The sunflower crop should be harvested 35 days after flower initiation or 25 days after flower completion to get higher seed yield, oil content and low seed moisture contents to minimize the post harvest losses and simultaneously vacate the field 5 to 10 days earlier for the subsequent crop.

Key words: ***Helianthus annuus*, sunflower, desiccants application, time of harvest, seed yield, Pakistan**

INTRODUCTION

Recent introduction of sunflower (*Helianthus annuus* L.) as a non-conventional oilseed crop, resulted in its acceptance in cotton-, rice- and potato-growing areas of

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Pakistan. The rotations cotton-sunflower-cotton, rice-sunflower-rice and sunflower-potato-sunflower are economical for the growers. However, a drawback in these rotations is in terms of delay in cotton and rice planting as the existing commercial sunflower hybrids mature in early June, which is simultaneously the peak time for cotton and rice planting. Commercially available desiccants can help to vacate the field 5 to 10 days earlier and, therefore, offer a partial solution to the problem. In advanced countries where mechanized harvesting and uniform ripening of sunflower crop are main objectives, desiccants application is a routine practice. Since manual harvesting of sunflower on larger area is extremely time-consuming, costly and inefficient, introduction of combine harvesting is an imperative.

Maturity of sunflower is never uniform, because of variability in germination, soil moisture and fertility levels in the field. The harvesting of wet, succulent and immature sunflower plants decreases the efficiency of the combine, damages the seed and consequently incurs extra cost for seed drying and cleaning. These problems generally discourages the growers, resulting in a low oilseed production in the country. In this situation, it has become important to harvest the crop at the earliest possible date, but without taxing the yield, in order to allow a timely planting of the subsequent crop. Such decision should be based on the knowledge of crop maturity time coupled with the use of appropriate desiccants.

Rana *et al*. (1990) used two herbicides, *i.e.*, Paraquat (1, $1^{/}$-dimethyl-4, $4^{/}$-bipyridinium ion (as dichloride salt 20% AS) and Fomesafen (5-[2-chloro-4-(trifluoromethy) phenoxy]-N-(methylsulfonyl)-2-nitrobenzamide 21% EC), applied alone and along with 2% v/v surfactant [Agral-90 (900 g/1 alkyl phenol ethylene oxide condensate)] as sunflower desiccants at NARC, Islamabad, Pakistan. They concluded that the effect of these desiccants on seed yield and oil content was not very pronounced. Since at that time there were no many desiccants available, tests were conducted on Paraquat, which was used as contact-type herbicide in potatoes, and Fomesafen, a non-selective broadleaf contact-type herbicide (William, 1994).

Recently, due to the availability of other chemicals, the scope of the same study was extended to explore the effectiveness of Dimethipine, Metoxuron (Dosanex), Drop-leaf and Diaquat as desiccants on sunflower. In USA, different doses of Dimethipine (1, 2, 3-dihydro -5, 6-dimethyl -1, 4-dithin -1, 1, 4, 4-tetroxide) were tested as desiccant on sunflower and reported to have enhanced crop maturity without loss of seed yield, oil content and quality (Ames *et al*., 1982; Ames and Waiz, 1988). Tombu (1988) also supported these results from France. Diaquat (6, 7-dihydrodipyrido [1, 2-a:$2^{/}$, $1^{/}$-c] pyrazinediium ion (9, 10-dihydro-8a, 10a-diazoniaphenanthrene-2A) has also been used successfully as harvest aid in sunflower (Thelwell and Bennett, 1988). It has been reported that physiological maturity in sunflower was attained when seed moisture content reached between 36 and 40% (Anderson, 1975), which required 35 days after floral initiation (Robertson *et al.*, 1978) or 25 days after floral completion (Ortegon, 1980). The objectives of this

study were to determine the relative efficacy of the desiccants and their consequent effect on seed yield and oil quality of sunflower.

MATERIALS AND METHODS

The experiment was conducted with four desiccants; Dimethipine, Metoxuron (Dosanex), Drop-leaf and Diaquat, for two years at National Agricultural Research Center (NARC), Islamabad, Pakistan. Sunflower hybrid NK-212 was planted on 21st February, 1990 and 31st January, 1991. Two rates of each desiccant were sprayed 15 days after flower completion. The experiment was laid down in a randomized complete block design, replicated four times. Experimental plot size of 18.75 m^2 was maintained to accommodate 5 rows of 5 m length, spaced 75 cm apart and with 25-cm distance between plants in the row. Two doses of each desiccant (Anonymous, 1974, and William, 1994) were mixed into a calibrated volume of water as carrier and were sprayed on sunflower foliage (Table 1). Solid-cone type brass nozzle was mounted on a knapsack manual sprayer to achieve complete wetting of the crop.

Two dates of harvesting were superimposed on each desiccant treatment, *i.e.*, 10 (D1) and 20 (D2) days after the spray. Uniform doses of fertilizers at the rates of 120 N and 60 P_2O_5 (kg/ha) were applied in the form of DAP and urea to each treatment. Half dose of nitrogen and whole phosphorus were mixed in the soil during land preparation, while the remaining nitrogen was applied at the time of second irrigation, when the plants attained 35-45 cm height. Planting was done by dibbler, putting 3-4 seed per hill at a depth of 3-5 cm. After germination, one seedling per hill was maintained by manual thinning. Third irrigation was applied at floral initiation stage. One hoeing after 30 days of planting and one hilling up just before floral initiation were done manually. Dimecron was sprayed against insect pest before flower initiation.

Data on plant height (PH), head diameter (HD), seed yield (SY), 100-achene weight (100-AW), moisture content (MC), oil content (OC) and fatty acid profile (FAP) were recorded. Plant height was measured from ground level to the receptacle of the head as an average of 10 plants selected randomly from the two central rows of each plot at physiological maturity stage. Head diameter was measured from the same 10 plants, from one edge of the head to the other. Two central rows were harvested for recording seed yield data. 100-Achene weight was taken as an average of three samples. Seed moisture content was recorded on a sensitive electronic balance at the time of harvest.

Oil content in sunflower seeds at zero percent moisture was measured by a Newpot Nuclear Magnetic Resonance, Model Oxford 4000 NMR Analyzer (Granlund and Zimmerman, 1975). Fatty acid composition, *i.e.*, palmitic acid (PA), linoleic acid (LA) and oleic acid (OA), were measured by Shimadzo gas liquid chromatograph (GLC), Model GC-9 A-A, using a 2.1 m x 3.2 mm glass column (column oven

was operated at 230°C) packed with 3% SP 2310 2% SP 2300 coated chromosorb WAW on 100/120 mesh. Methylating solution of 4 g metallic sodium prepared in 500 methanol was used for preparing oil methyl esters. The data collected were subjected to statistical analysis appropriate to split plot design, using microcomputers. Duncan's Multiple Range Test (Duncan, 1955) was used for separation treatment means and analysis of variance (Steel and Torrie, 1980).

Table 1: Desiccant treatments, application rates and their corresponding formulations applied on sunflower

Treatment	Common name	Chemical name	Formulation (a.i %)	Rate used (per ha)
T1	Dimethipine	1,2,3-dihydro-5,6-dimethyl-1,4-dithinn-1,1,4,4-tetroxide	25	1.50 l
T2	Dimethipine	1,2,3-dihydro-5,6-dimethyl-1,4-dithinn-1,1,4,4-tetroxide	25	2.00 l
T3	Metoxuron (Dosanex)	N-(3-chloro-4-methoxyphenyl)-N,N-dimethyl urea	80	0.75 kg
T4	Metoxuron (Dosanex)	N-(3-chloro-4-methoxyphenyl)-N,N-dimethyl urea	80	1.00 kg
T5	Drop-leaf	$NaClO_3$ (Sodium chlorate WSSA)	50	0.225 kg
T6	Drop-leaf	$NaClO_3$ (Sodium chlorate WSSA)	50	0.300 kg
T7	Diaquat	6,7-dihydrodipyrido [1,2-a:2$^{/}$,1$^{/}$-c] pyrazinediium ion (9,10-dihydro-8a, 10a-diazoniaphenanthrene-2A)	20	3.0 l
T8	Diaquat	6,7-dihydrodipyrido [1,2-a:2$^{/}$,1$^{/}$-c] pyrazinediium ion (9,10-dihydro-8a, 10a-diazoniaphenanthrene-2A)	20	4.0 l
T9	Control	(No desiccant was applied, except plane water)		

RESULTS AND DISCUSSION

On an average of the two years and in individual year, almost identical trends for seed yield and other agronomic traits were observed in this study. The desiccant treatment means were significantly different for all the traits except plant height, while there were non-significant effects for the rate of application of each desiccant on any agronomic character of sunflower. The dates of harvesting after application of desiccants were significant for oil content, linoleic acid, oleic acid and seed moisture contents and non-significant for plant height, head diameter, seed yield, palmitic acid and 100-achene weight. The interactions between desiccants and harvest dates were significantly different for all the traits except plant height (Table 2). Based on the pooled data of both years and two dates of harvesting after application of the desiccants, the seed yield ranged from 1667 to 2344 kg/ha among the different treatments. The highest yield of 2344 kg/ha was recorded in the control, where no desiccant was applied, while among the four desiccants, used at two rates, the highest seed yields of 2222 and 2342 kg/ha were noted in the lower and higher rates of Drop-leaf, respectively, followed by the lower and higher rates of Metoxuron (Dosanex) with the yields of 2121 and 2168 kg/ha, respectively.

Table 2: Effect of desiccant application and time of harvest on yield and oil quality of sunflower during 1990 and 1991

Treatment	PH (cm)			HD (cm)			Yield (kg/ha)			OC (%)		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1	169	171	170	14.0	14.4	14.2	1878	2101	1994	36.3	37.2	36.7
T2	172	171	171	13.5	13.3	13.4	1860	2038	1949	36.6	37.4	37.0
T3	169	169	169	14.2	13.0	13.6	1956	2285	2121	36.6	38.4	37.5
T4	173	170	172	13.9	13.4	13.6	2006	2329	2168	38.7	39.1	38.9
T5	175	172	173	14.0	13.1	13.6	2189	2255	2222	39.7	41.4	40.5
T6	170	172	171	14.2	13.3	13.8	2345	2338	2342	41.1	41.2	41.2
T7	171	170	170	14.7	12.3	13.5	1530	1803	1667	33.5	33.6	33.6
T8	174	167	171	14.5	12.4	13.4	1426	1921	1674	32.7	32.8	32.7
T9	175	168	172	14.3	11.7	13.0	2161	2527	2344	38.8	39.6	40.2
Mean	172	170	-	14.2	13.0	-	1928	2177	-	37.1	38.1	-
LSD 1	-	-	NS	-	-	0.7	-	-	233.2	-	-	1.5
LSD 2	1.9	-	-	NS	-	-	NS	-	-	1.0	-	-
LSD 3	NS	-	-	10	-	-	329.8	-	-	2.1	-	-
LSD 4	NS	-	-	1.4	-	-	515.7	-	-	3.8	-	-

Table 2: Effect of desiccant application and time of harvest on yield and oil quality of sunflower during 1990 and 1991 (continued)

Treatment	PA (%)			LA (%)			OA (%)			MC (%)			100-AW (g)		
	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean	D1	D2	Mean
T1	7.1	7.1	7.1	62.7	58.6	60.7	33.2	31.7	32.5	26	7	16.6	5.3	5.8	5.8
T2	7.2	7.0	7.1	62.3	58.2	60.2	28.3	32.8	30.6	26	9	17.5	4.9	6.0	5.9
T3	6.8	7.2	7.0	65.0	60.4	62.7	27.2	30.2	28.7	25	6	15.3	5.5	5.6	5.9
T4	6.5	7.1	6.8	59.3	60.7	60.0	32.3	31.0	31.6	23	6	14.6	5.5	5.6	6.2
T5	6.7	7.2	6.9	54.0	55.0	54.5	37.3	34.1	35.7	24	9	16.3	5.4	6.0	6.3
T6	6.0	7.9	6.9	51.6	56.7	54.1	40.6	32.5	36.6	26	7	16.6	5.5	6.0	6.2
T7	6.3	8.2	7.3	62.5	55.2	58.8	30.5	35.7	33.1	25	3	14.0	4.7	4.7	4.6
T8	7.1	6.9	7.0	62.4	51.5	57.0	28.7	40.2	34.5	30	7	18.4	4.6	5.1	4.7
T9	6.6	7.3	6.0	56.6	49.2	52.9	34.7	41.9	38.3	27	10	18.3	5.9	6.4	6.5
Mean	6.7	7.3	-	59.6	56.2	-	32.5	34.5	-	26	7	-	5.3	5.7	-
LSD 1	-	-	NS	-	-	3.3	-	-	3.9	-	-	NS	-	-	0.4
LSD 2	NS	-	-	1.9	-	-	1.9	-	-	7.1	-	-	NS	-	-
LSD 3	0.8	-	-	4.7	-	-	5.5	-	-	NS	-	-	NS	-	-
LSD 4	1.0	-	-	5.9	-	-	5.5	-	-	NS	-	-	NS	-	-

LSD 1 = (0.05) for desiccant
LSD 2 = (0.05) for harvesting dates
LSD 3 = (0.05) for desiccant x harvest dates
LSD 4 = (0.05) for desiccant x harvesting dates x years

The yields obtained with both rates of Drop-leaf and Dosanex were statistically similar to that of the control. Dimethipine at both rates reduced the seed yield significantly as compared with the control, Drop-leaf and Dosanex treatments. The lowest seed yields of 1667 and 1674 kg/ha were obtained with both doses of Diaquat, followed by 1949 and 1994 kg/ha with the respective doses of Dimethipine. Drop-leaf and Dosanex enhanced the seed yield of sunflower as compared with the other desiccants. Yields obtained from both harvesting dates after application of desiccants were not significantly different from each other, although a relatively higher yield was recorded for the second harvesting date (20 days after desiccant application) than for the first harvesting date (10 days after desiccant application), 2177 kg/ha and 1928 kg/ha, respectively. However, desiccants x harvest dates interaction for seed yield was statistically significant at 5% level of probability which indicates that the desiccants Drop-leaf and Metoxuron (Dosanex), enhanced the crop maturity by increasing seed yield and decreasing moisture contents in sunflower achenes.

Gathered from the pooled data of the two years and harvesting dates, the oil content was significantly different between various desiccants and their rates of application. Drop-leaf produced the highest oil contents of 41.2% and 40.5% at the two concentrations which were significantly higher than those produced by the other desiccants. Drop-leaf was followed by Dosanex and Dimethipine at both rates, 38.9 to 37.5 and 37.0 to 36.7%, respectively, which were statistically similar to that of the control. Diaquat produced the lowest oil contents of 33.6 and 32.7% at the two concentrations. Date of harvest affected the oil content. The harvesting after 20 days of desiccant application increased the oil content from 37.1% to 38.1%, *i.e.*, by 1% as compared with the first harvesting date (10 days after the application of the desiccants). The interaction desiccants x harvest dates for oil content was also significant at 5% level of probability. On mean basis, the moisture contents in seed obtained from different treatments and both harvesting dates were statistically non-significant for the various desiccants. Differences in seed moisture contents between the two dates of harvest were statistically significant. On average for the desiccants, the lowest moisture content of 7% was obtained from second harvesting date, in which the crop was harvested 20 days after desiccant application. The highest moisture content of 26% was recorded in the first harvesting date, in which the crop was harvested 10 days after application of desiccants. The interactions desiccants x harvest dates was non-significant for moisture content at 5% level of probability.

In pooled data, 100-achene weights were significantly different for the desiccants, while non-significant for the dates of harvests and desiccant x harvest date interactions. The highest 100-achene weight of 6.5 g was recorded in the control treatment, which was non-significantly different from both rates of Drop-leaf (6.3 and 6.2 g) and Dosanex (6.2 and 5.9 g). The 100-achene weight from the second harvest date (5.7 g) was significantly larger than that from the first harvest date (5.3

g). The interactions desiccants x harvest dates were non-significantly different at 5% level of probability. The trends in fatty acid profile, *i.e.*, palmatic acid, linoleic acid and oleic acid compositions, were similar to that of yield, oil content, moisture content and 100-achene weight.

CONCLUSIONS

Drop-leaf and Metoxuron (Dosanex) at the concentrations of 0.225 to 0.300 and 0.75 to 1.00 kg/ha, respectively, can be safely used as sunflower desiccants. On the average for the two years and in individual years, almost similar trends for seed yield and other agronomic traits were observed in this study. The desiccant treatment means were significantly different for all the traits except plant height, while there were non-significant effects for the rate of application of each desiccant on any agronomic character of sunflower. The dates of harvesting after desiccant application were also significant for oil content, linoleic acid, oleic acid and seed moisture contents and non-significant for plant height, head diameter, seed yield, palmitic acid and 100-achene weight. The interactions between desiccants and harvesting dates were significantly different for all the traits except plant height. The sunflower crop should be harvested 25 days after floral completion or 35 days after floral initiation for higher seed yield, oil content and lower seed moisture content achieved in a relatively short period, to vacate the field earlier in order to allow the subsequent crop to be planted on time in the same field. Similarly, the oil content was not affected by Drop-leaf desiccant application on sunflower.

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EFECTO DE APLICACIÓN DE DESECANTE Y TIEMPO DE COSECHA SOBRE EL RENDIMIENTO Y CALIDAD DE ACEITE EN EL GIRASOL (*Helianthus annuus* L.)

RESUMEN

Cuatro desecantes, Dimethipine, Metoxuron (Dosanex), Drop-leaf y Diaquat, fueron investigados en el experimento de campo efectuado en 1990 y 1991. Dos dosis de desecantes eran aplicadas al hibrido de girasol (*Helianthus annuus* L.) NK-212 durante 15 dias despues del fin de florescencia. Dos fechas de cosecka (10 y 20 dias despues de la aplicacion de desecantes) fueron combinadas con las variantes de desecacion. El objetivo de investigacion era de hacer constar la eficacia relativa de diversos desecantes aplicados en dos dosis, y dos fechas de cosecha, y su efecto sobre el rendimiento de semillas, la calidad de aceite y otras caracteristicas del girasol. Por termino medio para dos años, los valores medios de aplicación de desecantes eran considerablemente diferentes para todas las caracteristicas estudiadas. Los mas bajos rendimientos de semillas (en 1667 y 1674 kg/ha) fueron obtenidos con la mas baja y mas alta dosis de Diaquat. Mas altos rendimientos que esos por otros tratamientos fueron obtenidos con ambas dosis de Drop-leaf (2222 y 2342 kg/

ha) y Metoxuron (2121 y 2168 kg/ha). La aplicación de Diaquat y Dimethipine reducio considerablemente el rendimiento con respecto al control, de Drop-leaf y Metoxuron (Dosanex). El Diaquat causo la reduccion, y Drop-leaf el amuento del contenido de aceite. Fue concluido de Drop-leaf y Metoxuron (Dosanex) podian ser utilizados sin riesgo como desecantes para el girasol en dosis de 0,225 y 0,750 kg de materia activa/ha. La cosecha del girasol tiene que ser efectuada despues de 35 dias a partir del comienzo de florescencia o despues de 25 dias a partir del fin de florescencia. Por eso se obtiene mas grande rendimiento de semillas y del contenido de aceite, y mas bajo contenido de humedad en semillas, lo que reduce las perdidas despues de la cosecha y hace el campo libre para el cultivo siguiente en 5 a 10 dias mas temprano.

EFFET DE LA DESSICCATION ET DE LA DATE DE LA RÉCOLTE SUR LE RENDEMENT ET LA QUALITÉ DE L'HUILE CHEZ LE TOURNESOL (*Helianthus annuus* L.)

RÉSUMÉ

Les effets de quatre dessiccatifs, les Dimethipine, Metoxuron (Dosanex), Drop-leaf et Diaquat, ont été observés dans des champs expérimentaux en 1990 et 1991. Deux doses de dessiccatifs ont été utilisées pour traiter l'hybride de tournesol (*Helianthus annuus* L.) NK-212, 15 jours après la fin de la floraison. Deux dates de récolte (10 et 20 jours après le traitement) ont été combinées avec les traitements dessiccatifs. Le but de l'expérience était de déterminer l'efficacité relative de différents dessiccatifs appliqués en deux doses et à deux dates de récolte ainsi que leur influence sur le rendement en graines, la qualité de l'huile et d'autres caractéristiques du tournesol. Sur deux ans, les moyennes obtenues avec l'application des dessiccatifs étaient significativement différentes pour toutes les caractéristiques étudiées. Les rendements en graines les plus bas (1667 et 1674 kg/ha) ont été obtenus avec les doses les moins élevées ou les plus élevées, respectivement. Des rendements plus élevés qu'avec les autres traitements ont été obtenus avec des doses de Drop-leaf (2222 et 2342 kg/ha) et de Metoxuron (2121 et 2168 kg/ha). Une diminution significative du rendement par rapport au contrôle, Drop-leaf et Metoxuron (Dosanex) a été constatée à la suite de l'application de Diaquat et de Dimethipine. Le Diaquat a provoqué une diminution et le Drop une augmentation du contenu en huile. Il a été conclu que l'on peut utiliser sans risque le Drop-leaf et le Metoxuron (Dosanex) comme dessiccatifs du tournesol à des doses de 0.225 et 0.750 de matières actives/ha. La récolte du tournesol devrait donc être faite 35 jours après le début ou 25 jours après la fin de la floraison. Ainsi obtiendrait-on un plus grand rendement de graines et un plus grand contenu d'huile ainsi qu'un moindre contenu d'humidité dans la graine ce qui diminuerait les pertes après la récolte et libérerait les champs plus tôt pour les semailles suivantes.