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Effect of Foliar Diseases Control by Chlorothalonil on Pod Yield and Quality Characteristics of Confectionery Groundnuts (*Arachis hypogaea* L)

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Abstract: Effects of foliar diseases control by chlorothalonil fungicide on pod yield and quality characteristics were studied in 10 confectionery groundnut genotypes at ICRISAT Centre, India, during two rainy seasons. Significant treatment (disease control versus no control), and genotypic effects were observed for pod yield, total biomass, remaining green leaf area, retained leaf area damaged by rust, shelling percentage, 100-seed mass, oil content, fatty acids, and oleic (O)/linoleic (L) acid, and polyunsaturated (P)/saturated (S) fatty acid ratios. A significant increase in pod yield and total oil content was observed due to the control of foliar diseases by chlorothalonil; whereas the protein content remained unaffected by it. The foliar diseases control by chlorothalonil affected four fatty acids; linoleic acid content increased whereas stearic, oleic, and behenic acid contents decreased. Of the seed quality characteristics, a significant decrease in O/L ratio, and a significant increase in P/S ratio were observed under the disease control treatment. Response to disease control for pod yield and quality characteristics was influenced by genotypes and years. Correlations among fatty acid contents, in general, remained unaffected by control of foliar diseases with chlorothalonil whereas those of fatty acid contents with pod yield, seed mass, oil and protein contents changed in their significance and magnitude.

Key words: peanut, fatty acid composition, protein, chlorothalonil, rust and late leaf spot, correlation.

INTRODUCTION

About a third of the total groundnut (*Arachis hypogaea* L) production in the world is consumed in the form of edible nuts. Large-seeded varieties are likely to attract a premium price in the world market of edible nuts. However, foliar diseases such as rust (*Puccinia arachidis* Speg) and late leaf spot (*Phaeoisariopsis personata* (Berk. & M. A. Curtis) Deighton), which occur worldwide, can together cause well over 50% yield loss (Subrahmanyam and McDonald 1983; McDonald *et al* 1985) and affect the seed quality. Application of fungicides to control foliar diseases causes differential changes in seed mass, total oil and protein contents, and fatty acid composition of groundnut genotypes (Worthington and Smith 1973, 1974; Beuchat *et al* 1974; Rajgopalan and Vidyasekaran 1983, Sanders *et al* 1989). Studies by Hammond *et al* (1976) reveal that seeds harvested from unsprayed control plots had significantly better quality (dollar value per metric ton) when

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measured using standard Federal State Inspection Service methods (US DA 1974) than those treated with chlorothalonil, a fungicide used to control rust and leaf spots in groundnut. They indicated that although the seed quality in this case is not related to leaf spot control, certain fungicides adversely affect it probably by altering the ecology of geocarposphere leading to fungus related damage to seeds.

The present experiment was aimed to determine (i) the effects of rust and late leaf spot control by chlorothalonil on pod yield and quality characteristics; and (ii) the nature and magnitude of association among different traits in selected confectionery groundnut genotypes with and without foliar diseases control.

MATERIALS AND METHODS

Ten confectionery groundnut varieties were selected for this study. These varieties, which belong to subsp *hypogaea* var *hypogaea*, were developed at ICRISAT Centre for high pod yield, large seed mass, and improved seed quality characteristics. All these varieties were included in the Fourth International Confectionery Groundnut Varietal Trial that was sent to 22 countries. Of these, ICGVs 88382 and 88389 in India, ICGVs 88378, 88389, and 88399 in Korea, ICGVs 88386, 88367, and 88386 in Sri Lanka, ICGV 88382 in Vietnam, and ICGVs 88358 and 88386 in Zimbabwe have performed better than local control cultivars. They are now undergoing further evaluation in these countries.

These varieties were grown in a split-plot design with four replications during the 1990 and 1991 rainy seasons at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India. The trial in 1990 was sown on 23 June and harvested on 26 October, whereas in 1991 it was sown on 24 June and harvested on 29 October. The main plots consisted of spray treatments (disease control, chlorothalonil spray vs no disease control, water spray), and the subplots of genotypes. A four-row plot of 4 m length in 1990, and a five-row plot of 9 m length in 1991, with a common inter- and intra-row spacing of 75 and 15 cm, respectively, was adopted. The trial was grown in Alfisol fields in both the years with irrigation and it received 60 kg ha^{-1} P_2O_5 as basal application and 400 kg gypsum ha^{-1} at the peak flowering stage. The trial was protected against foliage damage by insect pests using appropriate insecticides. At 40 days after sowing (DAS), 1·15 kg ha^{-1} chlorothalonil (Kavach®) in 800 litres water was applied using a motorised knapsack sprayer. Subsequent sprayings were done at 10-day intervals to give a total of seven sprays in each season. Control plots were sprayed with 800 litres ha^{-1} water at the same intervals. Chlorothalonil was used to control both rust and late leaf spot which are most prevalent in the rainy season and generally appear around 40 DAS at ICRISAT Centre.

The percentages of remaining green leaf area (RGL) and retained leaf area damaged by rust and late leaf spot were determined on five plants per plot, 1 week before harvest as described by Subrahmanyam *et al* (1984). After harvest, observations on pod yield, total biomass (pod weight + haulm weight), and harvest index (pod weight/total biomass weight) were recorded on a whole-plot basis. One kg random bulk pods from each plot were shelled to determine the shelling percentage. Sound mature seeds from the shelling percentage samples were taken randomly to record 100-seed mass. The 100-seed mass samples were later analysed for total oil, protein, and for individual fatty acid contents.

Oil content was determined by using the nuclear magnetic resonance (NMR) procedure (Jambunathan *et al* 1985). The fatty acid methyl esters (FAME) of triglycerides were prepared following the method described by Hovis *et al* (1979) and the FAME were analysed as per the procedure described earlier (Dwivedi *et al* 1993).

From the fatty acid estimates, the following seed quality characteristics were determined as described by Mozingo *et al* (1988): (i) oleic (O)/linoleic (L) acid ratio = % oleic acid/% linoleic acid; (ii) polyunsaturated (P)/saturated (S) acids ratio = % linoleic acid/total saturated fat (TSF), where TSF = % palmitic acid + % stearic acid + % arachidic acid + % behenic acid + % lignoceric acid.

Analysis of combined data over 2 years was done in a split-plot design, using the GENSTAT software package. Genotypic means were used to estimate phenotypic correlations between yield and quality characteristics.

RESULTS AND DISCUSSION

Analyses of variance for various characters are presented in Table 1. Significant treatment (disease control versus no control) and genotypic differences were observed for pod yield, total biomass, shelling percentage, 100-seed mass, retained leaf area damaged by rust, oil content, palmitic, stearic, oleic, linoleic, and behenic acid contents as well as for O/L and P/S ratios. In addition, treatment difference for RGL and retained leaf area damaged by late leaf spot (LLS), and genotypic differences for harvest index, arachidic, eicosenoic, and lignoceric acid contents were also significant. Year effect for most of the characters was significant. Significance of various second- and third-order interactions is given in Table 1.

All genotypes had a significant increase in the mean RGL under chlorothalonil treatment. This increase ranged from 104 to 154%, showing effectiveness of chlorothalonil in rust and LLS control. This was further supported by a reduction in damage of retained leaf area by these two diseases in all the genotypes (Table 2). This

TABLE 1

Mean square for remaining green leaf area and retained leaf area damaged by rust and late leaf spot, pod yield, total biomass, harvest index, shelling percentage and seed mass, and quality characters of 10 confectionery groundnut genotypes grown under foliar-diseases controlled (chlorothalonil-sprayed), and control (water-sprayed) conditions, 1990 and 1991 rainy season, ICRISAT Centre[a]

Sources	*df*	*Remaining green leaf area* (%)	*Retained leaf area damaged by*		*Pod yield* ($t\ ha^{-1}$)	*Total biomass* ($t\ ha^{-1}$)	*Harvest index*	*Shelling* (%)	*100-seed mass* (g)	*Oil* (%)	*Protein* (%)
			Rust (%)	*LLS* (%)[b]							
Year (Y)	1	4463**	5930**	2156**	29·68**	320·80**	0·008	495**	22845**	1117·8**	48·5*
Error	6	165	247	19	0·06	0·76	0·001	18	40	3·9	5·6
Treatment (T)	1	73284**	12693**	2185**	26·21**	300·45**	0·004	188**	1576**	102·9**	0·8
Y × T	1	0	3179**	135	6·37**	40·70**	0·008	18	659**	22·1**	2·5
Error	6	323	88	36	0·24	0·71	0·003	13	33	1·5	4·2
Genotype (G)	9	26	53**	13	0·47**	1·54**	0·003**	25*	507**	13·5**	2·1
Y × G	9	38*	25**	12	0·11	0·86**	0·000	93**	166**	0·7	1·1
T × G	9	39*	18	9	0·20	0·35	0·002*	12	67*	2·8*	3·2
Y × T × G	9	31	23*	11	0·17	0·10	0·002*	19	17	1·6	1·4
Error	108	18	10	9	0·11	0·26	0·001	10	27	1·4	1·8

Sources	*df*	*Palmitic* (%)	*Stearic* (%)	*Oleic* (%)	*Linoleic* (%)	*Arachidic* (%)	*Eicosenoic* (%)	*Behenic* (%)	*Lignoceric* (%)	*O/L ratio*[c]	*P/S ratio*[d]
Year (Y)	1	13·11**	9·36**	0·27	14·70	4·86**	2·52**	25·20**	3·00**	0·046	0·280**
Error	6	0·10	0·08	4·77	3·22	0·04	0·02	0·06	0·03	0·029	0·005
Treatment (T)	1	0·26*	1·14**	4·36**	21·83**	0·03	0·00	0·80**	0·00	0·112**	0·162**
Y × T	1	0·06	0·83*	0·02	0·31	0·02	0·00	0·14*	0·07*	0·000	0·002
Error	6	0·04	0·11	0·21	0·34	0·02	0·01	0·02	0·01	0·003	0·003
Genotype (G)	9	2·59**	3·48**	26·40**	31·01**	0·64**	0·16**	0·96**	0·36**	0·207**	0·123**
Y × G	9	0·06	0·07	1·57	1·26	0·01	0·02**	0·03	0·03**	0·012	0·004
T × G	9	0·06	0·12	0·63	0·57	0·01	0·00	0·06*	0·01	0·006	0·002
Y × T × G	9	0·06	0·05	1·81	1·06	0·01	0·00	0·08*	0·03**	0·009	0·003
Error	108	0·07	0·07	1·28	0·94	0·01	0·01	0·03	0·01	0·007	0·003

[a] *, **: significant at 0·05 and 0·01 probability level, respectively.
[b] LLS, late leaf spot.
[c] O/L, oleic/linoleic acid ratio.
[d] P/S, polyunsaturated/saturated fatty acid ratio.

reduction was more pronounced in the case of rust than that of LLS, the latter being a more defoliating disease than the former. Genotypes responded differentially for increase in RGL with chlorothalonil treatment. The genotypic response was further influenced by years. The increase in mean RGL of genotypes was 26% in 1990 and 21% in 1991. The difference in RGL (5%) was smaller than the difference in pod yield (40%) and total biomass (20%) between the 2 years. Genotypes ICGVs 88367 and 88365 had an increase of 104 and 154% in RGL and their response to chlorothalonil application, when measured in terms of increase in yield, was similar (76%).

Mean pod yield, total biomass, and 100-seed mass increased, whereas shelling percentage decreased with foliar diseases control by chlorothalonil (Table 2). All genotypes showed significantly greater pod yield and total biomass in chlorothalonil-treated plots than in water-sprayed plots. However, the increase in these two characters in the chlorothalonil-treated plot was not consistent over years as indicated by the significant year × treatment interaction. The percentage of increase in pod yield and total biomass was 75% and 58% in 1990, and 35% and 38% in 1991. The increase in total biomass among genotypes was also not consistent, as indicated by significant year × genotype interaction. The pod yield advantage in these genotypes ranged between 24 and 76%. Such varied pod yield responses of genotypes to foliar diseases control by chlorothalonil spray is similar to those reported by previous workers (Sanden *et al* 1974; Subrahmanyam *et al* 1984; Subrahmanyam and Hassane 1990). ICGV 88389 gave the lowest mean increase of 24% in pod yield and 38% in total biomass.

Although the mean 100-seed mass was significantly greater in chlorothalonil-treated plots than in water-sprayed plots, these differences were significant only in case of ICGVs 88357, 88365, 88366, 88367, 88382, and 88386. The 100-seed mass in genotype ICGV 88378 did not change with disease control. The changes in the

TABLE 2

Effect of foliar diseases control by chlorothalonil on mean remaining green leaf area and retained leaf area damaged by rust and late leaf spot, pod yield, total biomass, harvest index, remaining green leaf area, shelling percentage, and 100-seed mass of 10 confectionery groundnut genotypes, 1990 and 1991 rainy seasons, ICRISAT Centre[a]

Genotype	Remaining green leaf area (%)		Retained leaf area damaged by Rust (%)		Retained leaf area damaged by LLS (%)		Pod yield (t ha^{-1})		Total biomass (t ha^{-1})		Harvest index		Shelling (%)		100-seed mass (g)	
	T_1[b]	T_2[c]	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
ICGV 88357	92.6 (75.7)	27.2 (31.0)	2.3 (8.4)	28.6 (30.4)	1.7 (6.8)	6.4 (14.2)	2.05	1.19	7.99	5.12	0.25	0.23	65	67	77	70
ICGV 88358	86.7 (71.4)	26.3 (30.5)	3.5 (9.9)	25.2 (28.6)	2.5 (7.7)	6.0 (13.5)	1.97	1.29	8.02	5.18	0.24	0.25	63	67	75	72
ICGV 88365	94.4 (78.2)	27.2 (30.8)	1.5 (6.8)	19.8 (24.6)	1.3 (5.8)	6.2 (13.8)	2.47	1.40	8.68	5.82	0.28	0.24	62	66	91	81
ICGV 88366	91.8 (75.6)	32.1 (34.3)	1.6 (7.1)	17.3 (23.1)	1.1 (5.6)	5.3 (12.6)	2.22	1.45	8.34	5.70	0.26	0.25	64	65	87	79
ICGV 88367	87.1 (71.3)	33.5 (34.9)	2.8 (9.1)	28.0 (30.0)	1.8 (7.0)	6.8 (14.5)	2.60	1.48	8.66	5.63	0.30	0.26	62	63	89	75
ICGV 88378	90.5 (73.4)	28.1 (31.7)	2.9 (9.2)	20.7 (25.4)	1.5 (6.4)	5.7 (13.0)	1.88	1.33	7.78	5.04	0.24	0.26	63	66	75	75
ICGV 88382	91.1 (74.9)	30.0 (32.8)	1.5 (6.9)	19.6 (24.2)	1.4 (5.9)	5.8 (13.3)	2.48	1.58	8.44	5.89	0.29	0.27	62	66	94	85
ICGV 88386	91.8 (76.2)	30.2 (33.0)	1.7 (7.3)	18.5 (24.0)	1.3 (6.1)	5.1 (12.5)	2.34	1.43	8.36	5.75	0.27	0.25	65	65	91	83
ICGV 88389	92.6 (75.9)	28.7 (32.1)	1.7 (7.4)	17.9 (23.2)	1.4 (6.3)	5.6 (13.0)	1.89	1.52	7.58	5.49	0.25	0.27	62	65	80	79
ICGV 88399	95.7 (78.4)	28.7 (31.9)	2.1 (8.1)	19.9 (25.0)	1.5 (6.4)	12.7 (17.7)	2.09	1.22	8.51	5.34	0.24	0.23	67	66	83	78
Mean	91.4 (75.1)	29.2 (32.3)	2.2 (8.0)	21.6 (25.8)	1.6 (6.4)	6.5 (13.8)	2.20	1.39	8.24	5.49	0.26	0.25	63	66	84	78
SE1[d]	(±1.494)		(±1.173)		(±1.091)		±0.119		±0.179		±0.003		±1.222		±1.848	
LSD (5%)	6.890		(4.216)		NS		0.354		0.544		0.033		3.185		5.230	
SE2[e]	(±2.009)		(±1.049)		(±0.671)		±0.055		±0.049		±0.006		±0.399		±0.642	
LSD (5%)	6.954		(3.629)		(2.322)		0.192		0.327		NS		1.383		2.222	

[a] Figures in parentheses are arcsine transformed values.
[b] T_1, foliar diseases control by chlorothalonil.
[c] T_2, no foliar diseases control (water spray).
[d] SE1, to compare T_1 and T_2 means for a given genotype.
[e] SE2, to compare T_1 and T_2 means over genotypes.

100-seed mass between spray treatments and among genotypes varied between years, and genotypes also responded differentially to spray treatments. Surprisingly the mean shelling percentage decreased in the chlorothalonil treatment. However, this decrease was significant for only three of the 10 genotypes—ICGVs 88358, 88365 and 88382—and varied with years. Increase in 100-seed mass and the decrease in shelling percentage, the two contradictory events in chlorothalonil treatment, could occur due to the procedure followed in recording these observations. For 100-seed mass, only sound mature seeds were observed, whereas for shelling percentage a 1 kg bulk pod sample was used, which included both mature and immature seeds. If we had recorded observations on the proportion of sound mature seeds in the shelling sample, this discrepancy may have been explained further.

Although disease control did not alter overall mean harvest index a significant increase was observed in two genotypes ICGV 88365 and ICGV 88367. With regard to harvest index, genotypes responded differentially to disease control and the response further varied with years.

The effect of foliar diseases control by chlorothalonil on total oil and protein contents, individual fatty acids, and O/L and P/S ratios is presented in Table 3. A significant increase in mean oil content (3.3%) over genotypes was observed in the chlorothalonil treatment, whereas protein content remained unchanged. The effect of foliar diseases control by chlorothalonil on oil content varied with genotypes and years. No interaction was significant for protein content. Although the mean protein content over genotypes did not change with chlorothalonil treatment, there were two varieties which showed significant changes. The protein of ICGV 88366 decreased by 9% whereas it increased by 7.3% in ICGV 88399. Protein/oil differences due to foliar diseases control by chlorothalonil were observed by other workers (Beuchat *et al* 1974; Rajgopalan and Vidyasekaran 1983; Sanders *et al* 1989). Among different fatty acids, the mean stearic, oleic, and behenic acid contents over genotypes decreased by 5%, 0.6%, and 3.6%, respectively, whereas mean linoleic acid content increased by 2.4% with foliar diseases control with chlorothalonil. These differences were significant. The changes in stearic and behenic acid contents caused by chlorothalonil application varied with years. These changes in behenic acid content were also influenced by genotypes. Although the mean lignoceric acid content between genotypes and spray treatments did not differ significantly, the year × genotype, year × treatment, and year × genotype × treatment interactions for this acid were significant. Significant changes were also observed in seed quality parameters: O/L ratio decreased by 3%,

TABLE 3

Effect of foliar diseases control by chlorothalonil on total oil and protein contents, individual fatty acids, and on O/L and P/S ratios of 10 confectionery groundnut genotypes, 1990 and 1991 rainy seasons, ICRISAT Centre

Genotype Treatment[a]	*Oil*[b] *(g kg⁻¹)*	*Protein*[b] *(g kg⁻¹)*	*Fatty acids*[b] *(g kg⁻¹)* Palmitic	Stearic	Oleic	Linoleic	Arachidic	Eicosenoic	Behenic	Lignoceric	*O/L ratio*[c]	*P/S ratio*[d]
ICGV 88357												
T_1	481·6	205·6	107·1	34·7	461·2	319·9	14·6	9·0	35·6	17·5	1·44	1·53
T_2	464·0	212·1	109·0	33·6	460·2	318·0	14·6	9·0	37·5	17·6	1·45	1·50
ICGV 88358												
T_1	493·4	215·4	105·4	32·2	471·5	312·1	14·5	9·9	35·9	18·4	1·51	1·51
T_2	470·5	214·4	106·0	34·2	478·6	301·4	14·7	9·5	36·7	18·4	1·59	1·43
ICGV 88365												
T_1	500·9	210·8	98·0	42·1	485·0	294·4	18·7	7·4	39·7	14·6	1·65	1·38
T_2	491·7	216·0	98·9	45·4	487·4	290·4	18·6	6·9	40·5	13·9	1·67	1·34
ICGV 88366												
T_1	510·9	205·3	99·9	41·1	478·2	303·7	17·7	7·2	38·0	14·4	1·58	1·44
T_2	484·9	224·6	101·5	41·4	478·9	297·6	17·9	7·5	41·0	14·6	1·61	1·38
ICGV 88367												
T_1	513·6	211·9	106·5	32·6	457·0	331·6	14·7	8·9	34·9	13·9	1·38	1·64
T_2	484·4	212·5	108·5	32·5	458·6	324·5	14·2	9·2	38·0	14·5	1·42	1·56
ICGV 88378												
T_1	501·4	220·5	100·0	38·5	486·5	298·9	17·0	7·9	37·0	15·0	1·63	1·44
T_2	491·9	215·6	101·9	40·1	486·5	294·2	17·1	8·1	36·6	15·5	1·65	1·39
ICGV 88382												
T_1	493·5	220·9	98·2	42·4	486·9	292·5	18·4	7·2	39·5	14·7	1·67	1·37
T_2	488·1	217·1	97·0	46·6	496·1	277·7	19·9	6·7	41·2	14·6	1·79	1·27
ICGV 88386												
T_1	508·5	215·8	96·4	42·5	494·0	288·4	19·1	6·7	38·7	14·1	1·72	1·37
T_2	489·6	218·3	97·9	44·6	494·5	281·2	19·6	6·9	41·1	14·2	1·78	1·29
ICGV 88389												
T_1	500·1	205·6	100·9	39·9	480·4	299·4	18·0	7·5	39·4	14·5	1·61	1·41
T_2	484·4	210·1	100·1	43·6	483·0	291·4	18·7	7·6	40·6	14·5	1·66	1·34
ICGV 88399												
T_1	483·5	220·9	104·2	35·1	488·5	301·1	15·2	8·2	33·2	14·5	1·62	1·49
T_2	477·5	205·9	103·9	36·0	498·4	291·1	15·2	8·1	32·7	14·4	1·72	1·44
Mean												
T_1	498·7	213·3	101·7	38·1	478·9	304·2	16·8	8·0	37·2	15·2	1·58	1·46
T_2	482·7	214·7	102·5	39·8	482·2	296·8	17·1	7·9	38·6	15·2	1·63	1·39
SE1[e]	±4·24	±4·70	±0·96	±0·93	±4·00	±3·42	±0·40	±0·26	±0·60	±0·36	±0·031	±0·018
LSD (5%)	11·90	NS	2·62	2·69	10·73	9·28	1·16	0·77	1·69	1·00	0·83	0·051
SE2[f]	±1·47	±2·28	±0·21	±0·37	±0·52	±0·65	±0·16	±0·12	±0·18	±0·10	±0·006	±0·006
LSD (5%)	4·74	NS	0·75	1·29	1·79	2·26	NS	NS	0·62	NS	0·021	0·020

[a] T_1, foliar diseases control by chlorothalonil; T_2, no foliar diseases control (water spray).
[b] Oil and protein contents and fatty acids determined from dry seed sample.
[c] O/L, oleic/linoleic acid ratio.
[d] P/S, polyunsaturated/saturated fatty acid ratio.
[e] SE1, to compare T_1 and T_2 means for a given genotype.
[f] SE2, to compare T_1 and T_2 means over genotypes.

whereas P/S ratio increased by 5% in the chlorothalonil treatment. Changes in fatty acid contents have been noticed with application of foliar fungicides by other workers (Worthington and Smith 1973, 1974; Sanders *et al* 1989). The alterations in fatty acid composition observed by Worthington and Smith (1973) were no larger than usual year to year differences observed in earlier studies (Worthington and Hammons 1971; Worthington *et al* 1972). Such changes, they suggested, could possibly be linked to extended period of plant vigour and change in the proportion of mature and immature seeds in treated plots. However these factors are unlikely to be responsible for changes in fatty acid composition in the present study as only sound mature seeds were used for chemical analyses. Sanders *et al* (1989) related such changes in oil quality to the differences in soil temperature because of varying foliage retention in disease-controlled plots. As soil temperature decreases, the degree of unsaturation increases in groundnut oil (Holaday and Pearson 1974) in response

TABLE 4

Phenotypic correlations (above diagonal foliar diseases controlled by chlorothalonil sprayed; below diagonal no foliar diseases control, water spray) between pod yield, seed mass, oil and protein contents, and individual fatty acid contents in groundnut[a]

	Pod yield	*Seed mass*	*Oil*	*Protein*	*Palmitic*	*Stearic*	*Oleic*	*Linoleic*	*Arachidic*	*Eicosenoic*	*Behenic*	*Lignoceric*
Pod yield	—	0·89**	0·42	0·06	−0·22	0·24	−0·08	0·07	0·25	−0·27	0·19	−0·48
Seed mass	0·71*	—	0·42	0·09	−0·54	0·57	0·29	−0·32	0·58	−0·62	0·44	−0·67*
Oil	0·67*	0·72*	—	−0·20	−0·44	0·30	0·00	0·00	0·42	−0·39	0·37	−0·59
Protein	0·42	0·33	0·39	—	−0·19	−0·01	0·51	−0·35	0·00	−0·02	−0·21	−0·09
Palmitic	−0·60	−0·90**	−0·75*	−0·39	—	−0·95**	−0·82**	0·89**	−0·97**	0·90**	−0·82**	0·53
Stearic	0·63*	0·86**	0·73*	0·44	−0·97**	—	0·72*	−0·84**	0·98**	−0·95**	0·86**	−0·53
Oleic	0·17	0·71*	0·49	0·03	−0·81**	0·68*	—	−0·96**	0·73*	−0·73*	0·45	−0·41
Linoleic	−0·36	−0·79**	−0·54	−0·22	0·93**	−0·84**	−0·95**	—	−0·83**	0·78**	−0·64*	0·33
Arachidic	0·67*	0·87**	0·72*	0·48	−0·97**	0·99**	0·65*	−0·83**	—	−0·94**	0·89**	−0·58
Eicosenoic	−0·54	−0·92**	−0·71*	−0·40	0·94**	−0·95**	−0·71*	0·83**	−0·94**	—	−0·71*	0·75*
Behenic	0·77**	0·59	0·48	0·68*	−0·60	0·71*	0·04	−0·33	0·75**	−0·62	—	−0·27
Lignoceric	−0·58	−0·79**	−0·80**	−0·10	0·61	−0·59	−0·45	0·43	−0·58	0·72*	−0·34	—

[a] * **, significant at 0·05 and 0·01 probability levels, respectively.

to differential solubility of oxygen required for desaturase activity.

The effects of foliar diseases control by chlorothalonil on the nature and magnitude of phenotypic correlation coefficients between pod yield and seed quality characteristics are shown in Table 4. All significant correlations among fatty acids under water-spray treatment maintained their nature and magnitude under the chlorothalonil treatment also. In addition, the correlations of behenic acid with palmitic, linoleic, and eicosenoic acids, which were non-significant in water spray treatment also became significant under chlorothalonil application. Many correlations of fatty acids with oil content, 100-seed mass, and pod yield, which were significant in water spray treatment, became non-significant under chlorothalonil spray. The correlations between oil content and fatty acid contents in chlorothalonil treatment were not significant. But in the water spray treatment, significant positive correlations between oil content and stearic and arachidic acid contents, and significant negative correlations between the former and palmitic, eicosenoic, and lignoceric acid contents were recorded. A significant positive correlation between pod yield and seed mass was observed in both chlorothalonil and water spray treatments. The association of oil content with pod yield and seed mass, which was significant in water-sprayed control was not significant in chlorothalonil treatment. A very strong negative association between oleic and linoleic acid content in the present study confirmed our earlier observation (Dwivedi *et al* 1993).

The present study showed a positive response to foliar diseases control by chlorothalonil for mean pod yield, total biomass, RGL, 100-seed mass, total oil content, linoleic acid content, and P/S ratio. On the contrary, shelling percentage, stearic, oleic, and behenic acid contents, and O/L ratio were decreased. Genotypes responded differentially to chlorothalonil application for yield and quality traits. Changes in seed quality, as measured by O/L and P/S ratios on sound mature seeds, were affected due to foliar diseases control. Produce from chlorothalonil-sprayed plots should have better nutritional quality but possibly shorter shelf-life than those obtained from water-sprayed plots.

The foliar damage by insect pests in the experiment was controlled by using appropriate insecticides as and when needed. Since insecticides were applied to both chlorothalonil and water-sprayed plots, the possible direct or indirect influence of the insecticides on pod yield and other quality characters will be common to both treatments barring any interaction between chlorothalonil and insecticides. The present study does not allow estimation of direct influence of chlorothalonil, if any, on pod yield and quality characters in groundnut. It is highly unlikely that chlorothalonil will be used on groundnut crop with no rust and LLS diseases.

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