Plant Archives Vol. 14 No. 2, 2014 pp. 805-809 ***ISSN 0972-5210***

INFLUENCE OF SULPHUR AND VARIETIES ON OIL QUALITY AND FATTY ACID COMPOSITION OF LINSEED (*LINUM USITATISSIMUM* L.)

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Abstract

A field experiment was conducted during 2007-08 at Student Instructional Farm, Narendra Deva University of Agriculture &Technology, Kumarganj, Faizabad (U.P.), India to study the influence of different levels of sulphur and varieties of oil quality and fatty acid composition of linseed. Results revealed that significantly highest oil content (36.65%) was obtained in variety Type-397 as compared to rest of the varieties of linseed. The similar results were also recorded on oil quality parameters *viz.*, iodine value (192.77), saponification value (196.84) and acid value (0.66) with linseed variety Type-397. The fatty acids profile was analyzed by gas liquid chromatography and highest content of linoleic acid was noticed in Type-397 variety, however, it was least in Shekhar variety of linseed. Maximum linolenic acid content was obtained in linseed variety Shekhar (45.23%) followed by Parvati and Type-397. Linseed variety Type-397 was found to the superior in respect of biochemical composition of fatty acid followed by Parvati and Shekhar. Significantly highest oil content and fatty acid composition of linseed with the application of highest tested dose of sulphur a.c.60 kg S/ha as compared to rest of the doses of sulphur.

Key words: Iodine value, acid value, oleic acid, linolenic acid, saponification value.

Introduction

India holds a premier position in the global oilseed production accounting for 19 per cent of total area and third position in total production covering about 13 per cent of the countries gross cropped area (www.google.com, 2003). Linseed occupies a greater importance among oilseeds owing to its specific use and special qualities. In India, it is mainly grown for seeds purposes which is use for extracting oil. The linseed oil is also used to a small extent in the soap and pharmaceutical industry. The paint and allied industry are major consumer of linseed oil in India which is accounting for 70 per cent of the total consumption. The oil of linseed has drying and hardening properties when exposed to the air and sunlight. Breeders have also produced linseed varieties that give oil with fatty acid profile that make them suitable for culinary uses. This is because of linola types containing high proportion of linoleic acid and low proportion of linolenic acid having appropriate stability and shelf life than the industrial types. A growing market has been identified for whole linseed in baking and health foods in comparison to the traditional "high linolenic" varieties which are suitable for culinary uses. The application of sulphur not only increases the productivity of linseed but also improved the quality and quantity of oil.

Linum is used in all pulmonary infections and chronic or acute constipation. It acts as a bulking and lubricating agent causing no irritation. Linseed oil is a valuable source of essential fatty acids which can help to prevent the fat deposits in the tissues. The oil has also been used to help the passage of gallstones. Very little work have been done on sulphur application in linseed varieties, hence present investigation was under taken to increase the oil quality and quantity as well as fatty acid profile of linseed.

Materials and Methods

A field experiment was conducted during rabi season of 2007-08 at Student Instructional Farm, Narendra Deva

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University of Agriculture &Technology, Kumarganj, Faizabad (U.P.), India to the study the influenced on different levels of sulphur on oil quality and fatty acid composition of linseed varieties. Treatment combinations comprised with three *viz.*, Shekhar, Parvati and Type 397 and four levels of sulphur *viz.*, 0, 20, 40, 60 kg/ha were evaluated with Randomized Block Design (RBD) with three replications. Recommended dose of fertilizers (NPK) @ 75:35:35 and different levels of sulphur were applied as per treatment through gypsum at basal decreasing. The crop of linseed was sown on second week of October and harvested on last week of March. The seeds of each variety were collected and stored in the desiccator for various biochemical analysis of the oil.

Oil percentage of linseed was estimated by the conventional Soxhlet method using petroleum ether as solvent (A.O.A.C., 1970). Iodine value of filtered oil was analyzed by using Hanus solution as given by Hart and Fisher (1971). Saponification Value of filtered oil collected from different sample was estimated as described by Hart and Fisher (1971). Acid value of filtered oil was determined by method described by Lees (1975). Oil samples collected from various varieties were converted in to methyl esters according to the procedure reported by Luddy *et al.* (1976) and the major fatty acids namely palmitic, stearic, oleic, linoleic and linolenic acids, were analyzed by "Gas Liquid Chromatography". Methyl esters of different fatty acids were estimated on fully computerized Gas Chromatograph, Methyl esters were used in the GLC to characterize different fatty acids. Percentage of fatty acid was based on peak area and retention time recorded by automatic computerized GC data processor. The Statistical analysis of the data obtained was carried out and critical difference was calculated by the method as suggested by Gomez and Gomez (1984).

Results and Discussion

A personal of data on seed yield of linseed was significantly influenced with the application of different dose of sulphur and linseed varieties. Linseed varieties Type 397 produce significantly highest seed yield (10.96 q/ha) as compared to Shekhar (9.71 q/ha) and Parvati (9.53 q/ha). Significantly highest seed yield (11.41 q/ha) of linseed was produced with the application of 60 kg S/ha as compared to rest of the levels of sulphur. It was also observed that the application of 40 kg S/ha produce significantly more seed yield (10.75 q/ha) of linseed as compared to 20 kg S /ha (9.53 q/ka) and control. The minimum seed yield (8.59 q/ha) of linseed was produced in control. The increase in seed yield of linseed with sulphur might be due to involved in the formation of chlorophyll, which promotes photosynthesis and activation of enzyme (Tandon, 1995). The results are in closed conformity with the finding of Upadhyay *et al.* (2012).

The oil content was significantly increased with increasing levels of sulphur and different linseed varieties. Significantly highest oil content (36.65%) of linseed was obtained in linseed variety Type 397 as compared to Parvati (35.77%) and (34.70%). Linseed variety Parvati also produced significantly higher oil content than Shaker (table 1). Application of sulphur @ 60 kg/ha produced significantly more oil content (37.02%) of linseed as compared to rest of the doses of sulphur application. Oil content of linseed was also significantly increased with the application of 40 kg S/ha than 20 and 0 kg S/ha. The minimum oil content in linseed seed was recorded in without sulphur application (control). Sulphur is involved in the formation of chlorophyll, activation of enzyme and improvement in oil content. Similar results have also been reported by Tendon (1995) and Upadhyay *et al.* (2012). Sulphur being the constituent of multi enzymes complex involving three sulphur containing coenzymes namely TPP, the SH redox system of lipoic acid and the SH group of coenzymes, which leads to the fatty acid biosynthesis. The oil content in the seeds depends on acetyl CoA formation and fatty acid biosynthesis. Sulphur helps in the conversion of carbohydrate into the oil (Chopra and Kanwar, 1991). In the fatty acid bio-synthesis, acetyl CoA is converted into Malonyl CoA. In this conversion, the enzyme acetyl thiokinase is involved. The activity of this enzyme depends upon sulphur supply. Morever, acetyl Co A contains Sulphur and sulphydryl group (Bonner and Verner, 1965). This may be a possible reason for increasing oil content of linseed by Sulphur application. Singh and Saran (1987) studied oil content in Indian linseed varieties and observed that highest oil content of 47.6 per cent was obtained in Neelum variety. The findings of the present investigation were also in according with the results of Dubey *et al.* (1987).

It was obvious clear from the data that Iodine value of linseed oil was significantly influenced by linseed varieties and sulphur application (table 1). Linseed variety Type 397 produced significantly higher Iodine content (193.2) as compared to Parvati (191.29) and Shekhar (189.53). The minimum Iodine value was recorded in linseed variety Shekhar. Application of sulphur up to highest tested dose (60 kg S/ha) produce significantly highest Iodine value (198.85) of linseed as compared to rest of the doses. Significantly more Iodine value (193.76) of linseed was obtained with the application of 40 kg S/ha than 20 and 0 kg S/ha. The minimum Iodine value

Table 1 : Seed yield, oil content, iodine value as influenced by various linseed varieties and sulphur levels.

S. no.	Treatments	Seed yield (q/ha)	Oil content (%)	Iodine value
A	**Varieties**			
	Shekhar	9.71	34.70	189.53
	Parvati	9.53	35.77	191.29
	Type 397	10.96	36.65	193.27
	S.E.m±	0.23	0.14	0.52
	CD at 5%	0.701	0.42	1.56
B	**Sulphur Levels (Kgha^{-1})**			
	0	8.59	34.23	184.25
	20	9.53	35.20	188.58
	40	10.75	36.39	193.76
	60	11.41	37.02	198.85
	S.Em.±	0.271	0.18	0.63
	CD at 5%	0.811	0.54	1.89

Table 2 : Saponification value and acid value as influenced by various linseed varieties and sulphur levels.

S. no.	Treatments	Saponification value	Acid value
A	**Varieties**		
	Shekhar	190.95	0.58
	Parvati	194.56	0.66
	Type 397	196.84	0.69
	SEm±	0.53	0.01
	CD at 5%	1.57	0.03
B	**Sulphur Levels (Kgha^{-1})**		
	0	187.60	0.59
	20	192.44	0.63
	40	197.11	0.66
	60	199.31	0.70
	SEm±	0.61	0.01
	CD at 5%	1.81	0.03

Table 3 : Linoleic acid (%) and Linolenic acid (%) as influenced by various linseed varieties and sulphur levels.

S. no.	Treatments	Linoleic acid (%)	Linolenic acid (%)
A	**Varieties**		
	Shekhar	15.08	44.08
	Parvati	16.14	42.60
	Type 397	17.74	41.10
	SEm±	0.32	0.42
	CD at 5%	0.93	1.23
B	**Sulphur Levels (Kgha^{-1})**		
	0	14.15	40.37
	20	16.02	42.43
	40	17.29	43.25
	60	17.88	44.34
	SEm±	0.37	0.48
	CD at 5%	1.07	1.42

Table 4 : Oleic acid (%), Palmitic acid (%), Stearic acid (%) as influenced by various linseed varieties and sulphur levels.

S. no.	Treatments	Oleic acid (%)	Palmitic acid (%)	Stearic acid (%)
A	**Varieties**			
	Shekhar	16.03	7.28	5.20
	Parvati	16.99	8.83	6.27
	Type 397	17.84	9.49	7.18
	SEm±	0.21	0.19	0.10
	CD at 5%	0.62	0.56	0.30
B	**Sulphur Levels (Kgha^{-1})**			
	0	15.59	7.12	5.50
	20	16.66	8.26	6.04
	40	17.55	9.04	6.41
	60	18.03	9.70	6.90
	SEm±	0.25	0.22	0.12
	CD at 5%	0.72	0.65	0.34

(184.25) of linseed oil was obtained in control plots. Singh *et al.* (1999) reported an increase in iodine value of 4.17 pre cent by application of 45 kg S/ha. This increase could be attributed by increase in the concentration of unsaturated fatty acids in the linseed oil. The iodine value measure of unsaturation of oil which is constant of particular oil or fat. It is useful parameter in studying the oxidative rancidity of oil, since higher the unsaturation, more the possibility of oil to go rancid (Thammaiha, 1999). The higher content of iodine value in linseed oil might be due to increase in unsaturated fatty acids such as linoleic and linolenic acid. The increase in essential fatty acid is desirable parameter to improve the oil quality. These results are in agreement to Indian standard institute (1984), Applequist and Olson (1972) and Abidi and Tripathi (1977).

Saponification value of linseed was significantly influenced by linseed varieties and application of sulphur (table 1). Significantly highest Saponification value was recorded in Type 397(196.84) followed by Parvati (194.56) and Shekhar (190.95). Application of 60 kg S/ha produce significantly highest Saponification value (199.31) of linseed oil as compared to rest of the doses of sulphur. Significantly more Saponification value (197.11). Linseed was also obtained with the application of 40 kg S/ha than 20 and 0 kg S/ha. Saponification value of oil indicates the molecular weight of fatty acid present in the oil this might be due to increase in saturation in fatty acid and reduction in the saturation oil. Similar range of saponification value of oil is also reported by www.google.com. Oxidative rancidity is chiefly due to oxidation of oleic acid. Hydrolic rancidity is usually measured by acid value (Thiammaiha, 1999). The similar range of acid value of linseed oil was also noticed by www.google.com. The fatty acid mainly linoleic acid, linolenic acid, oleic acid palmitic acid and stearic acid were estimated. The increase in Oleic acid, linoleic acid, linolenic acid might be due to acetate available with should converted into fatty acid being 18 carbon atom in the tryptophan of oil seed endoplasm the decrease in the ratio of palmitic acid was probably due to increase synthesis of 18 carbon fatty acid.

A perusal of data showed that acid value of linseed oil was significantly influenced by different linseed varieties and sulphur application. Maximum acid value (0.69) of linseed oil was obtained with linseed variety Type 397 followed by Parvati (0.66) and Shekhar (0.58). Application of sulphur @ 60 kg/ha produced maximum acid value (0.70) followed by 40 kg S/ha (0.66) and 20 kg S/ha (0.63). The minimum acid value (0.59) of linseed oil was recorded in without sulphur applied plots. The unpleasant effect of hydrolytic rancidity was noticeable in the oil containing palmitic, butyric and capric acids. Oxidative rancidity is chiefly due to oxidation of oleic acid. Hydrolytic rancidity is usually measured by acid value (Thiammiaha, 1999). The similar range of acid value of linseed oil was also noticed by (www.google.com).

Linoleic and linolenic acid content of linseed oil was significantly influenced by different linseed varieties and level of sulphur application (table 1). Maximum linoleic acid (17.74%) content was in Type 397 followed by Parvati (16.14%) and Shekhar (15.08%). Maximum linolenic acid content was recorded in Shekhar (44.08%) followed by Parvati (42.60%) and Type 397 (41.10 %). Every increasing dose of sulphur application significantly increased the linoleic and linolenic acid content of linseed oil. Linoleic and linolenic acid content was maximum with the application of 60 kg S/ha followed by 40 kg S/ha and 20 kg S/ha. The minimum linoleic and linolenic acid content was recorded in control.

Varying doses of sulphur application of linseed varieties significantly influenced the Oleic, Palmitic and Stearic acid content in linseed oil (table 1). Linseed variety Type-397 produced maximum Oleic acid (17.84%), Palmitic acid (9.49%) and Stearic acid (7.18%) of linseed oil followed by Parvati and Shekhar. The minimum Oleic (16.03%), Palmitic acid (7.28%) and Stearic acid (5.20%) was recorded in linseed variety Shekhar. Application of 60 kg S/ha recorded maximum oleic acid (18.03%), Palmitic acid (7.12%) and Stearic acid (5.50%) followed by 40 kg S/ha and 20 kg S/ha. The minimum Oleic acid (15.59%), Palmitic acid (7.12%) and stearic acid (5.50%) were obtained in without sulphur applied plots. Several environmental factors such as temperature, growing season, fertilizer, light and location considerably influence the fatty acid composition besides affecting the oil content. In oil seed unsaturation is brought about by desaturase enzyme which utilizes oxygen and supply of NADH. The desaturase enzyme has higher activity at 25^{0}C compared to the activity at elevated temperature (Mathur and Sharma, 1987). The significant increase in oleic acid, linoleic acid and linolenic acid might be due to acetate available which should convert into fatty acids having 18 carbon atoms in the protoplasts of oil seed endosperm. Further, it was found that formation of these acids was taken place in tissues of seeds from sugar moiety (Bowley and Black, 1978). The decrease in the ratio of palmic acid was probably due to increase in synthesis of 18 carbon fatty acids. On the other hands, linolenic acid has increasing relationship with oleic acid which could impact the nutritional quality of oil. The results are in accordance with Jaggi *et al.* (1997) also reported that palmitic, stearic, oleic and linoleic acid were decreased and linolenic acid increased in the flax oil. Mishra (2003) also reported an increase in the content of linolenic acid in linseed oil.

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