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Nitrogen, Sulphur and Thiourea Nutrition of Pearl millet [*Pennisetum glaucum* (L.) R. Br.] II. Effect on Yield and Yield Components

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Abstract: Response of pearl millet to nitrogen, sulphur, and seed and foliar application of thiourea, a sulphydryl compound, was studied under arid conditions for three consecutive seasons. Application of 40, 80 and 120 kg N ha^{-1} significantly increased mean grain yield by 46.7, 72.1 and 71.7% and stover yield by 16.9, 33.1 and 38.9%, respectively. Increase in yield due to N was a cumulative effect of significant increases in yield attributes (number of ears plant^{-1} by 7.2-9.9%, number of grains ear^{-1} by 11.0-27.2%, 1000-grain weight by 12.5-18.4%). Sulphur application had no significant effect on grain yield, even though the available sulphur content of the soil ranged between 8.4 to 8.9 ppm. The N:S ratio of leaves remained around 14, indicating presence of efficient mechanism for sulphur uptake and translocation by the crop. Pearl millet was thus identified as S-efficient crop. Foliar spray of 1000 ppm thiourea significantly increased yield attributes especially the 1000-grain weight. Dry matter distribution either in leaves or stems decreased due to thiourea spray and there was commensurate increase in dry matter distribution in ears leading to enhancement in capacity of developing grains to accept carbohydrates and consequent increase in yield by 0.181 t ha^{-1} over untreated control. Thiourea seed plus foliar treatment led to further improvement in grain yield.

Key words: Pearl millet, nitrogen, sulphur, thiourea, yield components.

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a major food crop of arid regions of south Asia and Africa. Though entirely rainfed cultivation under aberrant rainfall regime of 400 mm having a coefficient of variability between 40 and 70%, is the most overriding factor for low pearl millet productivity in arid regions, yet potentialities exist for improving the yield performance by managing soil resource. Since organic matter content of most soils of arid tropics is very low (0.10 to 0.25%), nitrogen management assumes an obvious priority in strategy for improving pearl millet productivity. Traditional systems that have maintained soil fertility through multi-year fallowing and use of legumes in rotation are being replaced by more intensive cereal cropping which is showing a tendency of negative nutrient balance. Nitrogen requirement and utilization by the crop plants is also contingent upon sulphur status of the soil, as maintenance of an optimum N:S ratio is essential for optimum crop

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growth and development (Dijkshoorn and Vanwijk, 1967). Such inter-relationship between nitrogen and sulphur in pearl millet nutrition, in arid agroclimate, however, has not been investigated so far.

Poor and inadequate plant stand has been reported as one of the major productivity constraints for pearl millet in the arid zone (Pearson, 1985). Pre-conditioning of seeds by soaking in solutions of biostimulants is known to improve seedling emergence and vigour (Khan *et al.*, 1979). Uppal and Banerji (1985) observed the growth regulating effects of substituted thioureas. Treatment of barley seeds with 500 ppm solution of N-methyl-N-2-(6 methyl pyridyl), a derivative of thioureas, enhanced the growth of seedlings. It was therefore, contemplated that a similar thiourea seed soaking may improve seedling emergence and initial growth and vigour of pearl millet plants under the harsh arid conditions. Limitations to yield in cereals have often been considered in terms of relative importance of the source (Photosynthesis) and the sink (grain growth), with little or no account being taken of the system transporting assimilates from source to sink (Evans and Wardlaw, 1976). The capacity of this system, however, may limit grain growth. Thus partitioning of assimilates between their sites of production in photosynthesizing leaves and their sites of utilization in harvestable regions is a major determinant of crop yield (Gifford and Evans, 1981). Studies of Gifford *et al.* (1984) and Salisbury and Ross (1986) have indicated that SH^- group has a role in dry matter partitioning and translocation of photosynthates in crop plants and consequently in crop yields. Thiourea is a sulphydral compound which contains one SH^- group (Jocelyn, 1972). The present investigation was therefore, designed to assess the influence of nitrogen, sulphur and thiourea in improving crop yields of pearl millet.

Materials and Methods

Details regarding location, treatments, application of fertilizers and rainfall received by the crop have been given in Parihar *et al.* (1997).

Results

Grain yield

Nitrogen application significantly increased the grain yield in all the three years and the seasonal variations were significant (Table 1). In 1989 grain yields under three N levels were comparable but in 1990 and 1991 the yields at 80 and 120 kg N ha^{-1} were significantly more. In pooled analysis effects S treatment on grain yield were not significant. Pooled data indicated that foliar and seed plus foliar treatments of thiourea significantly increased grain yield by 0.181 and 0.229 t ha^{-1} (9.6 and 12.2%), respectively, over untreated control.

Stover and biological yields

Nitrogen application significantly increased the stover yield, 80 and 120 kg N ha^{-1} were significantly superior to 40 kg N ha^{-1} in all the three years, but 120 kg N ha^{-1} was more effective than 80 kg ha^{-1} in 1990 and 1991 (Table 1). Mean increases with 40, 80 and 120 kg N ha^{-1} were 16.9, 33.1 and 38.9%, respectively,

Table 1. Effect of nitrogen, sulphur and thiourea application on yield of pearl millet

Treatment	Grain yield (t ha^{-1})				Stover yield (t ha^{-1})				Biological yield (t ha^{-1})			
	*S1	S2	S3	Pooled	S1	S2	S3	Pooled	S1	S2	S3	Pooled
Nitrogen (kg ha^{-1})												
0	1.13	1.79	1.17	1.36	4.55	4.47	3.80	4.27	5.67	6.26	4.97	5.64
40	1.27	2.53	2.19	2.00	4.87	5.29	4.83	5.00	6.14	7.82	7.02	7.00
80	1.33	3.04	2.66	2.34	5.74	6.06	5.26	5.69	7.07	9.10	7.92	8.03
120	1.27	3.03	2.71	2.34	5.82	6.47	5.52	5.94	7.09	9.46	8.24	8.26
CD (P=0.05)	0.09	0.21	0.17	0.16	0.30	0.23	0.20	0.23	0.39	0.42	0.36	0.37
Sulphur (kg ha^{-1})												
0	1.21	2.59	2.14	1.98	5.22	5.52	4.81	5.19	6.44	8.12	6.95	7.17
50	1.28	2.61	2.23	2.04	5.27	5.62	4.90	5.26	6.55	8.21	7.13	7.29
CD (P=0.05)	0.06	*NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thiourea application												
Untreated	1.29	2.42	2.04	1.88	4.98	5.37	4.67	5.01	6.17	7.77	6.71	6.89
Seed soaking	1.23	2.55	2.16	1.98	5.22	5.52	4.83	5.19	6.45	8.06	6.99	7.17
Foliar spray	1.28	2.68	2.24	2.06	5.34	5.66	4.92	5.31	6.62	8.31	7.16	7.36
Seed + foliar	1.30	2.75	2.29	2.11	5.44	5.75	5.00	5.40	6.74	8.51	7.29	7.51
CD (P=0.05)	0.07	0.16	0.16	0.13	0.25	0.15	0.16	0.19	0.32	0.30	0.28	0.29

*S1 = 1989, S2 = 1990, S3 = 1991, NS = Non-significant.

over control (4.27 t ha^{-1}). The effects of N on biological yield were largely similar, except that 80 and 120 kg N ha^{-1} were consistently comparable with each other. Seasonal variation in biological yield, as for grain yield, were significant. On the basis of pooled data, 40, 80 and 120 kg N ha^{-1} significantly increased biological yield by 1360, 2400 and 2630 kg ha^{-1}, representing increases of 24.1, 42.5 and 46.6%, respectively, over control. The effects of S fertilization on stover and biological yields were non-significant in all seasons. The effects of foliar and seed plus foliar treatments, with thiourea, however, were significant for both stover and biological yields in all three years. When compared with each other, these two treatments were found at par. Thiourea foliar treatment increased mean stover yield by 6% where as seed plus foliar treatment caused an increase of 7.7% over untreated control. The mean increase in biological yield obtained with thiourea foliar treatment was 478 kg ha^{-1} representing 6.9% increase over untreated control, while with thiourea seed plus foliar the mean increase was 625 kg ha^{-1} representing 9.1% increase over untreated control.

Harvest index

The effects of N on HI were variable in 1989, but in 1990 and 1991, effects showed consistent positive trends over control (Table 2). Pooled data, indicated increase in HI upto 80 kg N ha^{-1} and declined thereafter. The pooled data showed increases of 17.1, 19.7 and 15.8% at 40, 80 and

Table 2. Effect of nitrogen, sulphur and thiourea application on yield attributes of pearl millet

Treatment	No. of grains ear^{-1} (000')				1000-grain weight (g)				Harvest index (%)			
	*S1	S2	S3	Pooled	S1	S2	S3	Pooled	S1	S2	S3	Pooled
Nitrogen (kg ha^{-1})												
0	1.81	1.86	1.53	1.73	5.519	8.016	7.173	6.903	19.71	28.35	23.50	23.85
40	1.89	2.04	1.82	1.92	6.102	8.733	8.455	7.763	20.76	32.14	30.93	27.94
80	2.05	2.30	2.06	2.14	6.377	9.179	8.721	8.092	18.73	33.34	33.57	28.55
120	2.08	2.33	2.20	2.20	6.264	9.501	8.751	8.172	17.90	32.01	32.95	27.62
CD (P=0.05)	0.07	0.11	0.10	0.09	0.226	0.367	0.323	0.292	0.44	1.15	1.34	0.99
Sulphur (kg ha^{-1})												
0	1.94	2.11	1.89	1.98	5.999	8.740	8.236	7.658	18.93	31.39	29.90	26.74
50	1.98	2.15	1.91	2.01	6.132	8.975	8.314	7.807	19.62	31.53	30.58	27.24
CD (P=0.05)	*NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thiourea application												
Untreated	1.94	2.08	1.85	1.96	5.893	8.602	8.112	7.536	19.27	30.43	29.31	26.34
Seed soaking	1.91	2.10	1.90	1.97	6.119	8.790	8.175	7.695	19.21	31.18	30.49	26.96
Foliar spray	1.98	2.17	1.92	2.02	6.086	8.951	8.409	7.815	19.29	32.03	30.55	27.29
Seed + foliar	1.99	2.19	1.94	2.04	6.163	9.085	8.404	7.884	19.34	32.20	30.66	27.38
CD (P=0.05)	NS	0.08	NS	NS	0.192	0.250	0.221	0.216	NS	0.89	NS	NS

*S1 = 1989, S2 = 1990, S3 = 1991, NS = Non-significant.

120 kg N ha^{-1}, respectively, over control. Effects of thiourea foliar and seed plus foliar treatments were significant on HI only in 1990.

Yield components

Nitrogen application significantly increased number of grains ear^{-1} and 1000-grain weight (Table 2). The efficacy of 80 and 120 kg N ha^{-1}, however, was greater than that of 40 kg N ha^{-1}. But 80 and 120 kg N ha^{-1} levels were at par. The variations in number of grains per ear among seasons were significant for N treatments. On the basis of pooled data, 40, 80 and 120 kg N ha^{-1} significantly increased number of grains ear^{-1} by 11.0, 23.7 and 27.2%, respectively, over control. Corresponding increases in 1000-grain weight, which were significant in the pooled data were of the order of 12.5, 17.2 and 18.4%. The S application again proved ineffective in influencing number of grains ear^{-1} and 1000-grain weight. Thiourea foliar and seed plus foliar treatments were found to bring about significant increase in 1000-grain weight over untreated control, the increases were 3.7 and 4.6%, respectively.

Application of N significantly influenced the yield attributes (Table 3). Compared with control, application of 40, 80 and 120 kg N ha^{-1} significantly increased mean number of ears per plant by 7.2, 9.9 and 9.0%, respectively. Corresponding significant increases in mean ear length and ear weight were of the magnitudes of 4.9, 12.7 and 13.1%, and 11.8, 26.3 and 30.6% over control. Sulphur application failed to bring about significant effect on these parameters

Table 3. Effect of nitrogen, sulphur and thiourea application on yield attributes of pearl millet

Treatment	No. of ears plant^{-1}				Ear length (cm)				Ear weight (g)			
	*S1	S2	S3	Pooled	S1	S2	S3	Pooled	S1	S2	S3	Pooled
Nitrogen (kg ha^{-1})												
0	1.11	1.13	1.08	1.11	25.6	25.5	22.3	24.4	14.7	22.4	17.5	18.2
40	1.17	1.23	1.16	1.19	27.1	26.4	23.4	25.6	15.7	24.1	21.2	20.3
80	1.20	1.26	1.20	1.22	27.6	28.7	26.3	27.5	18.0	27.1	23.7	22.9
120	1.19	1.22	1.21	1.21	27.1	29.0	26.8	27.6	18.8	28.1	24.3	23.7
CD (P=0.05)	0.03	0.05	0.05	0.04	1.1	1.2	1.4	1.2	0.6	1.3	0.8	0.9
Sulphur (kg ha^{-1})												
0	1.16	1.20	1.16	1.17	26.8	27.3	24.7	26.3	16.6	25.2	21.5	21.1
50	1.18	1.22	1.16	1.19	26.9	27.5	24.7	26.4	16.9	25.6	21.8	21.5
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Thiourea application												
Untreated	1.14	1.20	1.13	1.16	26.5	26.5	24.0	25.7	16.0	24.2	21.0	20.4
Seed soaking	1.17	1.21	1.16	1.18	26.6	27.4	24.5	26.2	16.4	25.2	21.4	21.0
Foliar spray	1.18	1.20	1.18	1.19	26.9	27.6	25.0	26.5	17.1	26.0	21.8	21.7
Seed + foliar	1.17	1.23	1.18	1.19	27.4	28.0	25.2	26.9	17.5	26.3	22.4	22.1
CD (P=0.05)	*NS	NS	NS	NS	NS	NS	NS	NS	0.6	1.1	0.7	0.8

*S1 = 1989, S2 = 1990, S3 = 1991, NS = Non-significant.

in comparison to control in all the three years (Table 3).

Thiourea did not show significant effects on number of ears plant^{-1} in any of the three seasons. The length of ear underwent significant improvement only in 1990 though there were increasing trends in 1989 and 1991. In the case of ear weight, thiourea seed soaking was ineffective but the effects of thiourea foliar and thiourea seed plus foliar treatments were significant in all the three years. When compared with untreated control, thiourea foliar and thiourea seed plus foliar treatments increased mean ear weight by 6.1 and 8.1%, respectively.

Dry matter distribution among plant parts

Dry matter distribution (DMD) increased in ears with a fall in stem weight indicating reallocation of dry matter due to application of nitrogen (Fig. 1). Effect of S application was not significant. In respect of thiourea treatments, distribution of dry matter in ears showed consistent improvement with a fall in weight of stems and or leaves. Thiourea seed plus foliar treatment showed marked effects (Fig. 1).

Nitrogen:Sulphur (N:S) ratio

Nitrogen application brought about significant variations in N:S ratio of leaf, stover and grain but application of S and thiourea proved ineffective in influencing this parameter (Table 4). The effects of N were consistent in case of N:S ratio of stover and grain but in leaves the variations were negligible. Application of 40, 80 and 120 kg N ha^{-1} brought N:S ratio of grains to 11.7, 12.7 and 13.3 from 11.1 in control.

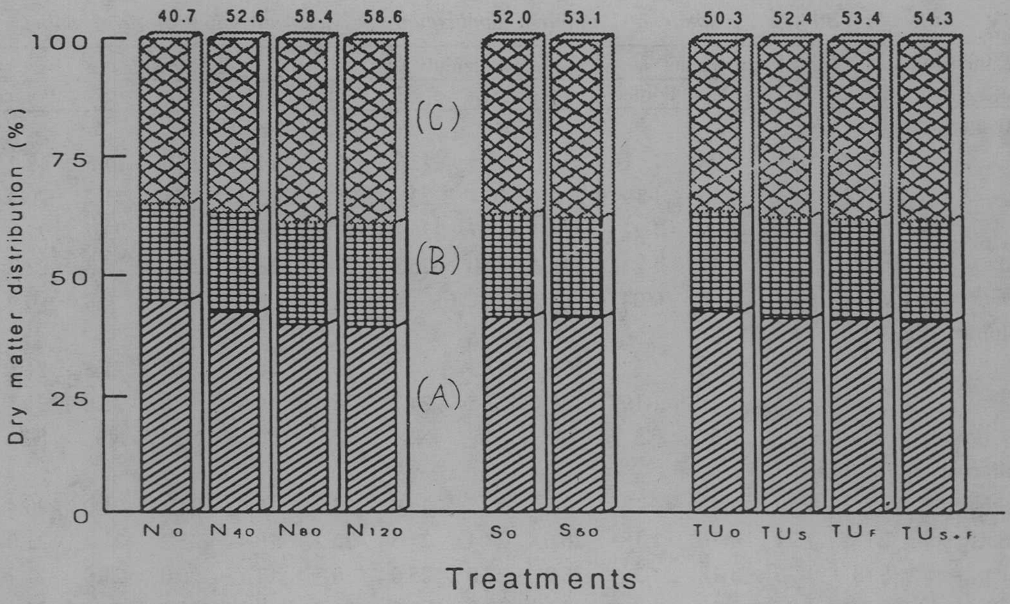

Fig. 1. Dry matter distribution in stem (A), leaves (B) and ears (C) as influenced by nitrogen, sulphur and thiourea application.

The ratio in stems ranged between 7.7 and 8.9, and in leaves between 13.9 and 15.2.

Discussion

Seasonal variation in yield

Annual variations in grain yields recorded in the present study merits explanation, because crop response to the levels of N showed some variation (Table 1). In 1989, mean grain yield reached a value of 1329 kg ha^{-1}, while in 1990 and 1991 grain yields reached a maximum of 3037 and 2710 kg ha^{-1}, respectively.

The temporal variations in the weather parameters of the three experimental years reveal that during grain filling period of the crop in 1989, there occurred moisture shortage. In 1990 moisture stress did not occur during grain filling and in 1991 life saving irrigation (50 mm) was given at 60 DAS, a period coinciding with flowering of the crop. Another adverse effect on grain development in 1989 might have been exerted by the high temperatures (35°C) prevalent during grain filling. This caused forced maturity as the crop was harvested about a week earlier in 1989.

Effect of nitrogen

Nitrogen fertilization increased mean number of ears plant^{-1} by 7.2-9.9%, ear length by 4.9-13.1%, number of grains ear^{-1} by 11.0-27.2% and 1000-grain weight by 12.5-18.4% in comparison to control. Individual ear weight increased by 11.8-30.6% over control. Remarkably, grain yield increased by 46.7-72.0% due to N application. Clearly, therefore, increased grain yield was cumulative effect of increases in yield attributes (Tables 2 and 3). This is further supported by the existence of significant

Table 4. Effect of nitrogen, sulphur and thiourea application on N:S ratio (Pooled over 3 years)

Treatment	N:S ratio		
	Leaves	Stem	Grain
Nitrogen (kg ha^{-1})			
0	13.9	7.7	11.1
40	14.1	8.3	11.7
80	14.8	8.7	12.7
120	15.2	8.9	13.3
CD (P=0.05)	*NS	0.8	0.8
Sulphur (kg ha^{-1})			
0	14.5	8.4	12.2
50	14.5	8.5	12.3
CD (P=0.05)	NS	NS	NS
Thiourea application			
Untreated	14.5	8.4	12.0
Seed soaking	14.6	8.4	12.3
Foliar spray	14.4	8.4	12.3
Seed + foliar	14.5	8.5	12.3
CD (P = 0.05)	NS	NS	NS

positive correlation between grain yield and the yield attributes (ear length r = 0.81, number of ears plant^{-1} r = 0.81, number of grains ear^{-1} r = 0.83, 1000-grain weight r = 0.88, harvest index r = 0.65). By and large, 80 kg N ha^{-1} proved superior to 40 kg N ha^{-1}, while 120 kg N ha^{-1} was as good as 80 kg N ha^{-1}. Superiority of 80 kg N ha^{-1} over 40 kg N ha^{-1} appears to have resulted on account of improved crop growth and better expression of yield attributes, favoured by improved N nutrition, which could be verified by the significant positive correlation coefficient between grain yield and N content of grain (r = 0.658, 0.877 and 0.912 in 1989, 1990 and 1991, respectively). A part of the increased efficacy of 80 kg N ha^{-1} *vis-a-vis* 40 kg N ha^{-1} seems to have resulted from improved crop photosynthesis even during the later part of grain filling as evidenced by significantly greater number of green leaves (Parihar *et al.*, 1997). Obviously photosynthetically active leaf surface was larger under 80 kg N ha^{-1} on account of delayed leaf senescence due to sustained availability of N in the crop plants during grain filling, particularly because application of N has been found to prevent chlorophyll degradation and leaf senescence in rapeseed-mustard (Patil *et al.*, 1997).

Effect of sulphur

Application of 50 kg S ha^{-1} had no significant effect on grain yield of pearl millet, even though the available S content of the soil ranged between 8.4 to 8.9 ppm, a level at which crops like sesame and mustard have been found to benefit from S fertilization (Chundawat, 1988; Joshi *et al.*, 1998). None of the yield parameters of the crop was influenced significantly, under S treatment. Hazra (1992) suggested a normal value of N:S ratio in leaf tissues of gramineous plant is between 14-16. In other words a S deficient cereal would be expected to have N:S ratio greater than 16. In the present study, not only N:S ratio of leaves was around 14 (Table 4) but also the ratio did not exceed even 15 in any of the three years, clearly suggesting that the crop did not experience a nutritional deficiency of S for normal growth and development. This is why the crop largely failed to benefit from exogenous S application. Sarkar *et al.* (1991), while studying the response of pearl millet to S fertilization (0, 20, 40 and 60 kg ha^{-1}) for two seasons in semi-arid condition, also observed no yield advantage, even though available S content of the soil increased from 8.0 ppm to 15.1 ppm due to S application. It therefore appears convincing to infer that perhaps S uptake and translocation mechanism in pearl millet is efficient, obviating the need for supplemental S addition. Pearl millet can, therefore, be termed S-efficient crop.

Effect of thiourea

In cereals grain yield is the ultimate goal and therefore, partitioning of dry matter between grain and vegetative parts is of great importance (Donald and Hamblin, 1976). The partitioning of dry matter in crop plants depends on the distribution between leaves, stem and ears before anthesis and on the reallocation of stem and leaf reserves after anthesis (Sahu and Solanki, 1991). In the present study dry matter distribution either in leaves or stems decreased due to thiourea spray in all the three years and there was a commensurate increase in dry matter distribution in ears, suggesting reallocation of leaf and stem reserves to the developing grains (Fig. 1). Significant improvement in 1000-grain weight in all the three seasons clearly points out that the capacity of developing grains to accept carbohydrates was enhanced due to the foliar spray of thiourea over untreated control (1883 kg ha^{-1}). Thus, increased grain yields obtained with thiourea foliar and seed plus foliar treatments were a result of increased crop photosynthesis, favoured by both photosynthetic efficiency and photosynthetic transport. Significant increases in both stover and biological yields of the crop under thiourea spray treatments lend further credence to this contention.

References

Chundawat, M.S. 1988. Response of sesame to levels and sources of sulphur. *Annual Progress Report Zone IA*, ARS Mandor-Jodhpur.

Dijkshoorn, W. and Vanwijk, A.L. 1967. The sulphur requirements of plants as evidenced by the N:S ratio in the organic matter. *Plant and Soil* 26: 129-157.

Donald, C.M. and Hamblin, J. 1976. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Advances in Agronomy* 28: 361-405.

Evans, L.T. and Wardlaw, I.F. 1976. Aspects of comparative physiology of grain yield in cereals. *Advances in Agronomy* 28: 301-359.

Gifford, R.M. and Evans, L.T. 1981. Photosynthesis, carbon partitioning and yield. *Annual Review of Plant Physiology* 32: 485-509.

Gifford, R.M., Thorne, J.H., Hitz, W.D. and Giaquinta, R.T. 1984. Crop productivity and photoassimilate partitioning. *Science* 22: 801-808.

Hazra, C.R. 1992. Fertilizer use in forages, pastures and grasslands. In *Non-Traditional Sectors for Fertilizer Use* (Ed. H.L.S. Tandon), pp. 30-47. FDCO, New Delhi.

Jocelyn, P.C. 1972. *Biochemistry of* SH^- Group. Academic Press London.

Joshi, N.L., Mali, P.C. and Saxena, A. 1998. Effect of nitrogen and sulphur application on yield and fatty acid composition of mustard (*Brassica* *juncea* L.) oil. *Journal of Agronomy and Crop Science* 180: 59-63.

Khan, A.A., Karseen, C.M., Lene, E.F. and Roe, C.H. 1979. Pre-conditioning of seeds to improve performance. In *Plant Regulation and World Agriculture* (Ed. T.K. Scott), pp. 395-413. Pleneum Press, New York.

Parihar, G.N., Sahu, M.P. and Joshi, N.L. 1997. Nitrogen, sulphur, and thiourea nutrition of pearl millet [*Pennisetum glaucum* (L.) R.Br.] I. Effect on growth and dry matter production. *Annals of Arid Zone* 36: 353-362.

Patil, B.N., Lakkineni, K.C. and Bhargava, S.C. 1997. Ontogenic changes in growth and assimilate distribution as influenced by N supply in rapeseed-mustard. *Journal of Agronomy and Crop Science* 178: 15-21.

Pearson, C.J. 1985. Editorial: Research and development for yield of pearl millet. *Field Crops Research* 11: 113-121.

Purohit, S.S. and Chandra, K. 1981. Reversal of Dikegulac - Sodium induced chlorophyll degradation and chlorophyllase activity in *Helianthus annuus* by urea. *Current Science* 5: 964-965.

Sahu, M.P. and Solanki, N.S. 1991. Role of sulphydryl compounds in improving dry matter partitioning and grain production of maize (Zea mays L.). *Journal of Agronomy and Crop Science* 167: 356-359.

Salisbury, F.B. and Ross, C.W. 1986. *Plant Physiology*. Wandsworth Publishing Company, U.S.A.

Sarkar, A., Faroda, A.S. and Bhatia, P.C. 1991. Studies on sources of sulphur in pearl millet wheat sequence under semi-arid conditions. *Indian Journal of Agronomy* 36: 148-152.

Uppal, K.S. and Banerji, K. 1985. Substituted thiourea as growth regulator. *Indian Journal of Agricultural Chemistry* 18: 85-89.