http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (12): 2020-2023, 2000

Maturity Dates Affect Soybean Seed Constituents: Protein, Oil, Ash and Moisture

Shad K. Khalil[1], John G. Mexal[2] and Leigh W. Murray[3]
[1]Department of Agronomy, NWFP A.U. Peshawar, Pakistan
[2]Department of Agronomy and Horticultre, New Mexico State University, USA
[3]Department of Experimental Statistic, New Mexico State University, USA

Abstract: The quality of soybean seed at harvest is dependent on the field production environment during development and maturation on the plant. These investigations were conducted to evaluate the effect of planting dates on soybean protein, oil, ash and moisture content. Soybean seeds were planted in the Spring (January 13, January 16, February 19, and March 1) and in the Fall (July 10, July 20, July 26, and August 25, 1991) at Agricultural Research Institute, Tarnab, Peshawar, Pakistan. Planting dates were manipulated in such a way that seed developed and matured at high temperature for spring planted crops, while seed development and maturation occurred at low temperature for fall planted crops. Mature seeds that developed under these conditions were analyzed for differences in composition. Protein, oil, and ash contents were strongly affected by planting date (different temperature at pod fill). Seed that matured at high temperature (spring planting) resulted in higher protein, oil, and ash content than the seed that matured at low temperature (fall planting). A positive correlation was found between protein and oil content and protein and ash content. The effect of temperature during pod filling stage was much greater than the temperature during early growth. Protein, oil and ash contents were positively correlated with temperature during pod filling stage, and increased with each increment of temperature. Moisture content was unaffected by planting date.

Key words: Soybean, maturity dates, seed constituents

Introduction

The supply of protein and oil (meat and fish) is becoming scarce especially in developing countries (Jimenez *et al.*, 1991). New sources of protein and oil have been devised in the developed countries. Among these, soybean has *great potential due to its high protein and oil content* (Hartwig and Kilen, 1991).

Soybean can possibly play a major role in narrowing the gap between the production and consumption of protein and oil in Pakistan, provided it can be fitted into the cropping husbandry (Beg, 1985). As an inexpensive source of protein, it can play a major role in elevating nutritional standards of developing nations, which are facing protein deficiencies (Chaudhry, 1985).

The protein content of soybean is influenced by environment in which the crop is grown (Wilcox and Cavens, 1992; Baenziger *et al.*, 1985; Fowler and De la Roche, 1975) cultivar (Rao *et al.*, 1993) and nitrogen rate and time of N application (Memon and Jamro, 1988; Vaughan *et al.*, 1990). However, protein content of the seed is said to be four times more dependent on environmental conditions than on variety (Benzain and Lane, 1986). For example, the range of levels of protein within a single cultivar exposed to a variety of different temperatures may be as great as the range in diverse cultivars grown at a single temperature (Nelson *et al.*, 1987).

The relative levels of oil in soybean seed can be influenced substantially by the temperature to which the developing seeds are exposed (Rennie and Tanner, 1989). Cool temperatures produce seed with low oil content and lower levels of palmitic and oleic acid and higher levels of linoleic and linolenic acid (Wolf *et al.*, 1982).

Wolf *et al.* (1982) evaluated the effect of temperature (18-33 °C) on chemical composition of soybean seed, and reported a positive relationship between temperature and protein or oil content but no relationship with moisture content. Hartwig and Kilen (1991), Singh *et al.* (1990) and Benzain and Lane (1986) also reported positive relationships between temperature and protein content of soybean, chickpea and winter wheat. However, Shafii *et al.* (1992) *reported an inverse relationship between* temperature and oil of winter rapeseed. These studies suggests that levels of protein and oil would change with changes in temperature during seed development and maturation.

Soybean planting in Pakistan typically occurs during two seasons, i.e. January to March, and July and August. Soybean planted in January to March that matures in June and July is traditionally called the spring crop, while soybean planted in July and August that matures in October and November is called the fall crop. This study was conducted to examine the relationships between spring or fall planting on oil, protein, ash and moisture content.

Materials and Methods

Soybean cultivar 'Swat 84' which belongs to maturity group 111 was planted at Agricultural Research Institute, Tarnab, Peshawar, Pakistan during 1991. Planting was done on four dates during the spring (January 13, January 16, February 19 and March 1) and four dates in the fall (July 10, July 20, July 26, and August 25). Soybean were planted in open field except January 13, which was planted in young persimon orchards. The spring planting dates were ready for harvest on June 30, July 2, July 8 and July 18, while fall planting dates were ready for harvest on Oct. 26, Nov. 11, Nov. 13, and Nov. 22.

Seeds from each date were harvested, threshed, cleaned and stored in refrigerator at 6 ± 1°C until the seeds from the last planting date were processed. Seeds harvested from all dates were evaluated for percent protein, oil, ash and moisture according to procedures described by the AOAC

Table 1: Proximate chemical analysis of soybean seeds as affected by different planting dates. Values in parenthesis are P values for mean square values above it

		Mean Squares			
Source	D.F.	Protein	Oil	Ash	Moisture
Dates	7	9.991 (<0.01)	5.115 (<0.01)	0.2965 (<0.01)	0.3533 (<0.01)
Error	16	0.332	1.259	0.0515	0.4314
C.Total	23				

(1990). The experiment was conducted using a completely randomized design with three replications. The data were analyzed by the procedure of the Statistical Analysis System SAS Proc GLM (1990), and LSD test was employed for mean separation when the F-values were significant. The data was also analyzed using linear regression analysis techniques (Snedecor and Cochran 1989). A preliminery experiment conducted on seed harvested from spring crop 2 weeks after harvest almost showed similar amount of protein, oil and ash as determined after storage until seed from fall crop was harvested.

Results

Soybean planted in spring developed and matured pods in May and June when the maximum air temperature was 32-43 °C, while fall planted crop developed and matured pods when maximum air temperature was 25-35 °C (Fig. 1).

Protein: Protein content was significantly affected by planting date (Table 1). Soybean seed harvested from the January 16 planted crop produced the maximum amount of protein (33.75%), followed by seed harvested from February 19 planted crop (Fig. 2). Protein content decreased as planting was delayed. The lowest amount of protein (28.47%) was observed from seed harvested from August 25 planted crop. Protein content was positively associated with temperature (Fig. 3). The protein content increased by 0.45% with each 1 °C temperature increase during pod filling stage.

Oil: Significant variation occurred in oil content due to planting date (Table 1). Seed harvested from January 16 planted soybean produced maximum quantity of oil (24.23%), followed by seed harvested from February 19 planted soybean (Fig. 4). Oil content decreased with later planting. Seed harvested from August 25 planted soybean had only 20.01% oil content.

There was a strong linear relationship between oil content and temperature (Fig. 5). Oil content increased by 0.29% with each 1 °C temperature increase during pod filling stage.

Ash: Planting dates significantly affected seed ash content (Table 1). Maximum ash content (5.80%) was observed for seed harvested from January 16 planted soybean (Fig. 6). Delayed sowing resulted in reduced ash content. Maximum reduction in ash content (5.01%) was observed when sowing was delayed up to July 26.

Strong positive relationship was observed between ash content and temperature (Fig. 7). Ash content increased by 0.075% with each 1 °C temperature increase during pod filling stage. Value for January 13 planted soybean was omitted, since its value was outlier.

Moisture: Seed harvested from all planting dates showed no significant effect on moisture content (Table 1). Al planting dates produced seeds with almost the same amount of moisture content (Fig. 8).

Discussion

Mean values presented in Fig. 2 to 5 reveal that as the date of planting was delayed from January 16, there was a reduction in protein and oil content of soybean. Seeds harvested from the spring planted crops were exposed to high temperature during seed development and maturation, while seed harvested from the fall crop did not experience high temperature during development and maturation, because average air temperature was low (Fig. 2).

Protein content of the seed was highest when seed developed and matured at high temperature. These results are consistent with the findings of Wolf *et al.* (1982), Singh *et al.* (1990) Rao *et al.* (1993), Hartwig and Kiler (1991), Benzian and Lane (1986), and Suryavanshi *et al.* (1993) who reported increases in protein content of soybean, wheat and sesame when the seed on mother plant developed and matured at comparatively high temperature. However, our results contradict the findings of Shafii *et al.* (1992) who reported decreased oil content of winter rapeseed at higher temperature. Our results can not be compared with Shafii *et al.* because winter rapeseed is basically adapted to low temperature and high temperature may decrease the oil content. Generally the protein content over all planting dates (29-33.8%) is lower than the average protein content (35-44%) reported in the literature, while oil content (20-24.4%) is higher than the average oil content (17-22%). The temperatures during pod filling stage were low which might slows nitrogen uptake. This idea is supported by Benzain and Lane (1986) who suggested that increasing air temperature increases the nitrogen uptake by the grain during the grain filling period which increases the nitrogen mass fraction of the grain. The other possible reason of low protein and high oil content may be related to cultivar where selection for high oil content resultes in lower protein content (Thorne and Fehr, 1970).

The possible cause of low protein content of seed harvest from January 13 planting may be because the crop was planted in a young persimon orchard and the seed therefore matured under partial shade. This partial shade protected the crop from exposure to high temperature during seed development and maturation may explain the low protein and oil content compared with January 16 and February 19 which matured at higher temperature. This appears to contradict the findings of Norberg *et al.* (1993) who reported increase in oil content of meadowfoam plants while studying the effect of cover and shading. on the oil yield. Their cover and shade treatment however, increased the temperature and resulted in more oil content than control.

Early planting, that is spring planting (January to March), resulted in more oil content than late planting (July and August). The seed harvested from early planted soybean developed and matured at high temperature, and resulted in more oil than late planted soybean. Wolf *et al.* (1982), and Suryavanshi *et al.* (1993) also reported high oil content from seed matured at high temperature compared with seed matured at low temperature. Rennie and Tanner (1989) suggested that temperature (15-40 °C) may affect the expression of genes, which affect the relative activity of

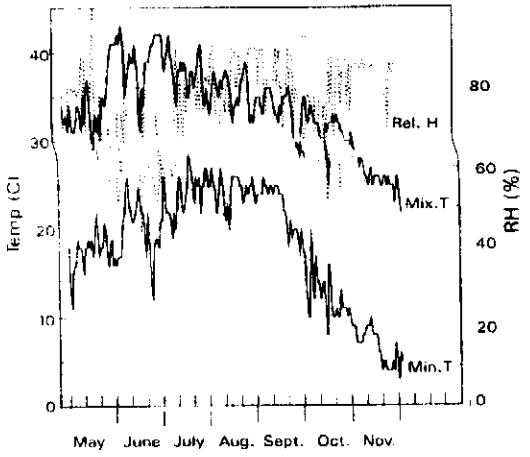

Fig. 1: Daily maximum, minimum temperature (C) and relative humidity (%) during growing season (1991)

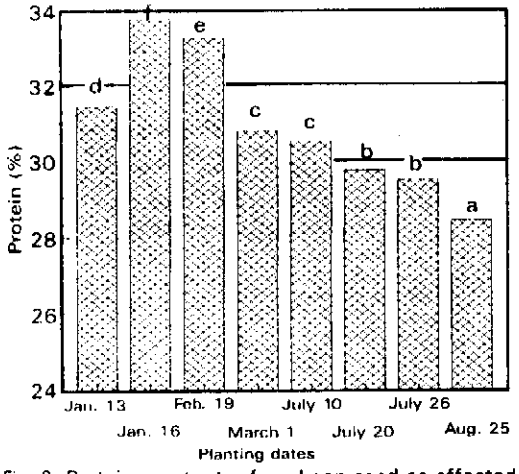

Fig. 2: Protein content of soybean seed as affected by planting dates. Bars with similar letters are not significant at alpha = 0.05 using LSD.

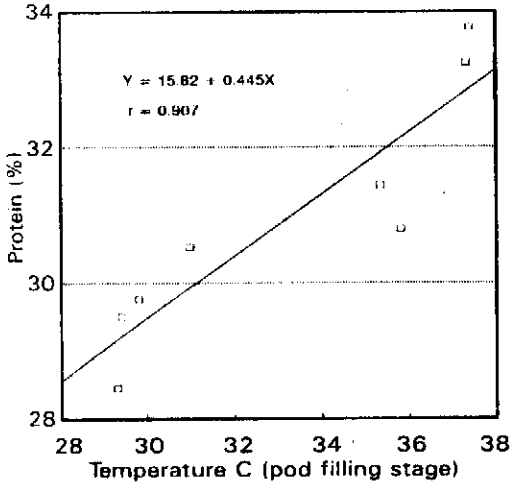

Fig. 3: Relationship of protein with temperature during pod filling stage

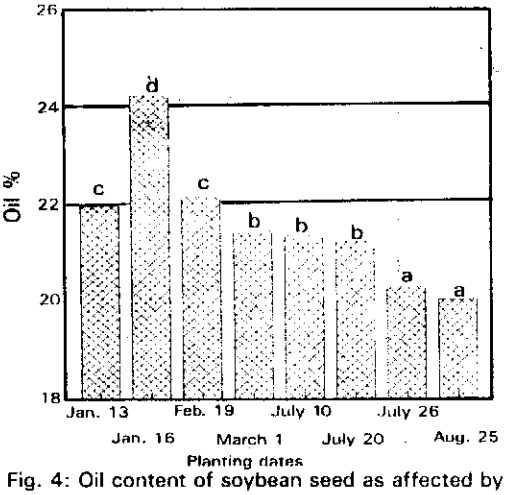

Fig. 4: Oil content of soybean seed as affected by planting dates. Bars with similar letters are not significant at alpha = 0.05 using LSD.

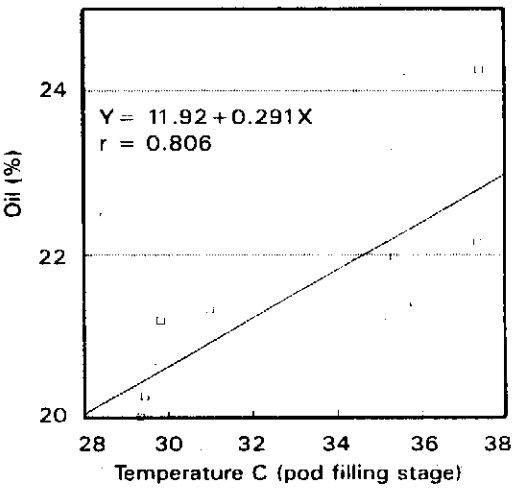

Fig. 5: Relationship of oil with temperature during pod filling stage

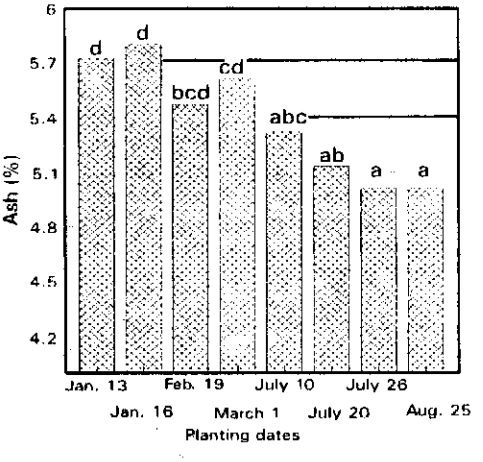

Fig. 6: Ash content of soybean as affected by planting dates. Bars with similar letters are non significant at alpha = 0.05 using LSD.

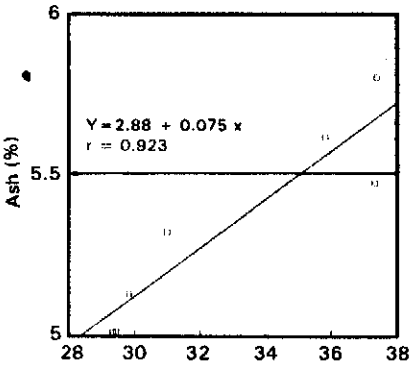

Fig. 7: Relationship of ash content with temperature during pod filling stage. Outllier ash = 7.7 % dropped from the equation

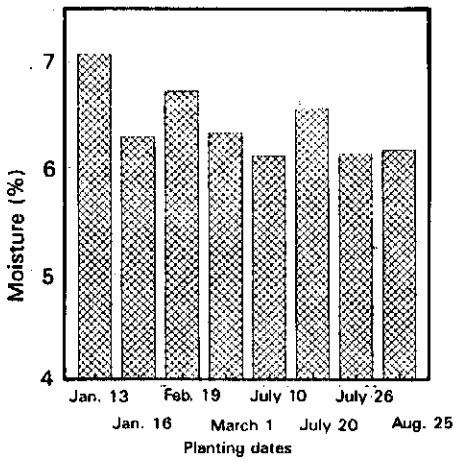

Fig. 8: Moisture content of syobean as affected by planting dates

enzymes responsible for oil.

Seed protein and oil content are associated with environment. The data suggests that a growing environment that favors the production of seeds with high protein content also favors the production of seeds with high oil and ash content. These findings agree with the results of Wolf *et al.* (1982) Baenziger *et al.* (1985), Wilcox and Cavins (1992), Singh *et al.* (1990), Rao *et al.* (1993), Sethi *et al.* (1990) who reported positive association of temperature with protein or oil content.

Moisture content was unaffected by planting dates. It should be noted that moisture content may be greatly influenced by storage conditions after harvest. However, all the seeds were stored in the same place under the same conditions, any differences in moisture content caused by growing temperature probably would be noticeable.

The results showed that soybean seeds harvested from early planting dates (spring planting) that matured during hot weather conditions produced seeds with high protein, oil and ash content. Seeds harvested from later planting (fall planting) that reached maturity after hot weather conditions had passed, generally exhibited low protein, oil, and ash content. Protein, oil and ash were positively associated with temperature during pod filling stage and increased with each 1 °C temperature increase.

References

Association of Official Analytical Chemists, 1990. Official metho of analysis of the Association of Official Analytical Chemis 15th ed. AOAC Inc. Arlington, VA.

Baenziger, P. S., R. L. Clement, M. S. McIntosh, W. T. Yamaza T. M. Starling, D. J. Sammons and J. W. Johnson, 1985. Eff of cultivar, environment and their interaction and stabil analysis on milling and baking quality of soft red winter whe Crop Sci., 25:5-8.

Beg, A., 1985. Soybean: Its potential in Pakistan. pp: 62-68. Proceedings of national seminar on oil seed research a development in Pakistan held in Islamabad, May 7-9.

Benzain, B. and P. W. Lane, 1986. Protein concentration of gra in relation to some weather and soil factors during 17 years English winter-wheat experiments. J. Sci. Food Agric., 37:4 444.

Chaudhry, A., 1985. Constraints of provinces in expanding a under non-conventional oil seeds, pp: 29-37. In: Proceedings national seminar on oil seed research and development Pakistan, held in Islamabad, May 7-9.

Fowler, D. B. and I. A. De la Roche, 1975. Wheat qual evaluation 111. Influence of genotype and environment. Can. Plant Sci., 55:263-269.

Hartwig, E. E. and T. C. Kilen. 1991. Yield and composition soybean seed from parents with different protein, similar yie Crop Sci., 31:290-292.

Jimenez, M. D., J. I. Cubero and A. D. Haro. 1991. Genetic a environmental variability in protein, oil and fatty a composition in high-alkaloid white lupins (*Lupinus albus*). J. S Food Agric., 55:27-35.

Memon, G. H. and G. H. Jamro, 1988. Influence of nitrog fertilization on grain protein content and NPK content of straw late sown wheat (*Triticum aestivum* L.). Pakistan J. Sci. I Res., 31:649-650.

Nelson, R. L., P. J. Amdor and J. H. Orf. 1987. Fatty a composition of oil from different soybean line grown at a unifo temperature. US Dept. Agric. Tech. Bull., No 1718.

Norberg, O. S., T. E. Fiez, G. D. Jolliff, M. Seddigh and J. Crane, 1993. Shading and crop-cover effects on meadowfoam yield. Agron. J., 85:183-187.

Rao, A. C. S., J. L. Smith, V. K. Jandhyala, R. I. Papendick and F. Parr, 1993. Cultivar and climatic effects on the prote content of soft white winter wheat. Agron. J., 85:1023-102

Rennie, B. D. and J. W. Tanner, 1989. Fatty acid composition of from soybean seeds grown at extreme temperature. J. Am Oil. Chem. Soc. 66:1622-1624.

Rubel, A., R. W. Rinne and D. T. Cavin. 1972. Protein, oil, and fa acid in developing soybean seeds. Crop Sci., 12:739-741.

SAS Institute. 1990. SAS user's guide: Statistics. Version 6, 4 e vol 2, SAS Inst., Cary, NC.

Sethi, K. L., R. L. Sapra and R. Gupta. 1990. Performance of pop cultivars in relation to seed, oil and latex yields under differe environments. J. Sci. Food Agric. 52:309-313.

Shaffii, B., K. A. Mahler, W. J. Price and D. L. Auld. 199 Genotype x environment interaction effects on winter rape se yield and oil content. Crop Sci., 32:922-927.

Singh, R. B., P. C. Williams and H. Nakkoul, 1990. Influence growing season, location and planting time on some quali parameters of Kabuli chickpea. J. Sci. Food Agric., 15:429-44

Snedecor, G. W. and W. G. Cochran. 1989. Statistical metho Eight edition Iowa State University Press / AMES.

Suryavanshi, G. B., V. S. Pawar, N. K. Umrani and S. K. Ransin 1993. Effect of sowing date on yield and quality of sesan (*Sesamum indicum*) varieties. Indian J. Agric. Sci., 63:496-49

Thorne, J. C. and W. R. Fehr. 1970. Incorporation of high prote exotic germplasm into soybean population by 2 and 3 w crosses. Crop Sci., 10:652-655.

Vaughan, B., D. G. Westfall and K. A. Barbarick, 1990. Nitrog rate and timing effects on winter wheat grain yield, grain protei and economics. J. Prod. Agric., 3: 324-328.

Wilcox, J. R. and J. F. Cavins, 1992. Normal and low lenolen acid soybean strains. Response to planting date. Crop Sc 32:1248-1251.

Wolf, R. B., J. F. Cavins, R. Kleiman and L. T. Black, 1982. Effe of temperature on soybean seed constituents: oil, protei moisture, fatty acids, ammino acids and sugars. J. Amer. C Chem. Soc., 59:230-232.