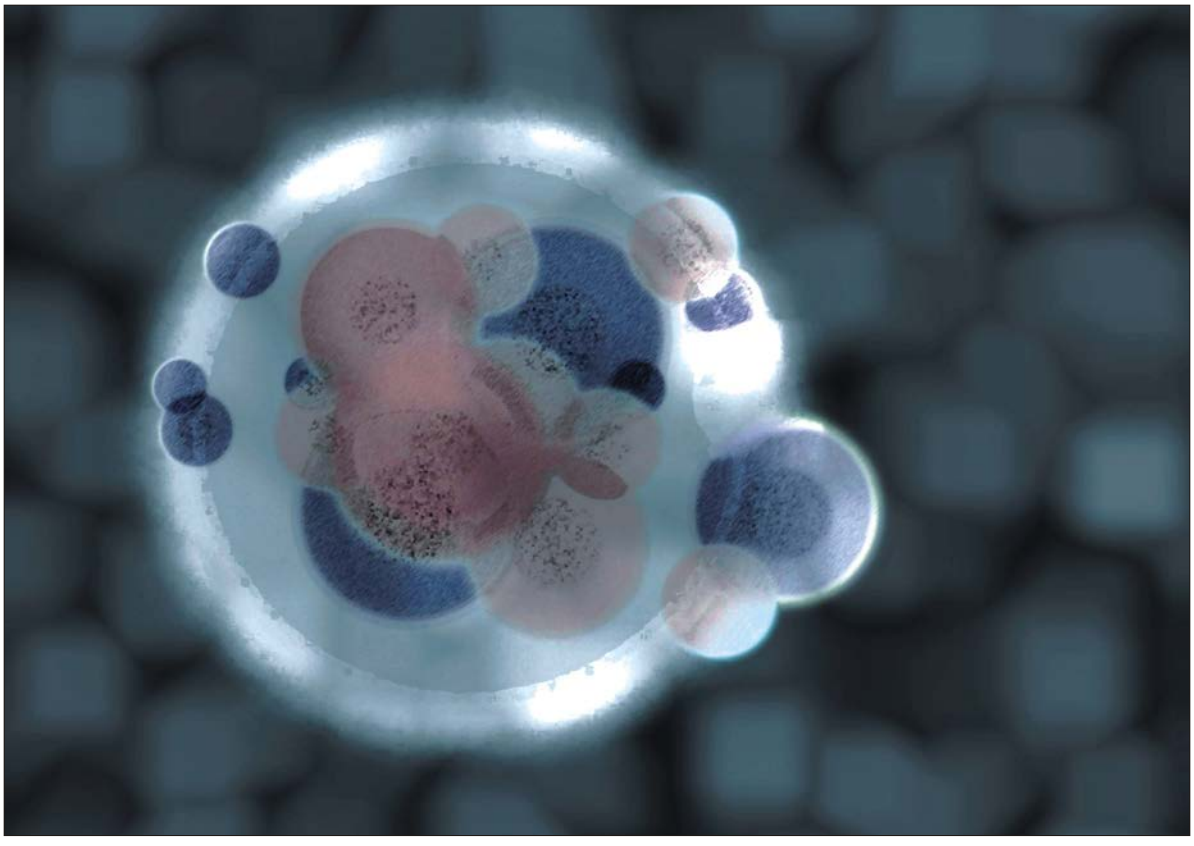

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Planting Date and Plant Density Effects on Protein and Oil Contents of Soybean Varieties under the Environmental Condition of Peshawar, Pakistan

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Abstract: Protein and oil contents of soybean varieties were significantly affected by planting date and plant density. Late planted crop gave more protein content than early planted crop, while an inverse relationship was found for oil content. Lower plant density of 200 thousand plants ha^{-1} gave significantly more protein content than higher plant densities of 400 and 600 thousand plants ha^{-1} and the same response was observed for oil content but the difference among the plant densities did not reach the 5% significance level. Epps produced more protein and oil contents than William-82. There was no effect of plant density on Oil concentration in seeds of William -82, however Oil concentration in seeds of Epps decreased with increase in plant density, indicating differential response of Oil concentration in seeds of the two soybean varieties.

Key words: Planting dates, densities, protein and oil contents

Introduction

The supplies of proteins and oils especially from animal sources (meat and fish) are becoming expensive and scarce particularly in developing countries (Jimenez *et al*., 1991). New sources of proteins and oils have been explored in the developed countries. As an inexpensive source of proteins, soybean can play a major role in elevating nutritional standards of foods in developing nations, where human beings are facing protein deficiencies (Chaudhry, 1985). Soybean can possibly play a major role in narrowing the gap between the production and consumption of proteins and oils in Pakistan, provided it can be fitted into the cropping husbandry (Beg, 1985). Mature seeds contain about 35-44% protein, 17-22% oil, 17% cellulose and hemicellulose, 7% sugars, 5% crude fiber and about 6% ash on a dry weight basis (Rubel *et al*., 1972). The protein and oil contents of soybean is influenced by environment in which the crop is grown (Wilcox and Cavins, 1992; Rao *et al*., 1993). However, protein content of the seed is said to be four times more dependent on environmental conditions than on variety (Benzian and Lane, 1986). Wolf *et al*. (1982) 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. Though it is deemed that conditions in NWFP are more favorable for quality production of soybean crop. The effects of environmental conditions during seed development and maturation on protein and oil contents have not been fully explored under agro-climatic conditions of Peshawar in autumn. Therefore, an experiment was designed to examine the relationship between autumn planting dates and planting density on protein and Oil contents of soybean varieties.

Materials and Methods

The experiment was carried out at the Agriculture Research Farm, NWFP Agricultural University Peshawar, during 1997 and 1998. The site is located at 34° N latitude, 71.3° longitude and an altitude of 450 meters above sea level. Peshawar is located about 1600 km north of the Indian ocean and thus has a continental climate. The soil of the experimental site was silty clay loam with a clay type montmorillonite, low in nitrogen (0.03-0.04%), low in organic matter (0.7-0.8%) and alkaline in reaction with a pH of 8.0-8.2. A basal dose of 36 kg N and 92 Kg P_2O_5 in the farm of Diammonium phosphate (D.A.P) fertilizer was applied at sowing. Indeterminate variety William-82 (MG-III) and determinate variety Epps (MG-V) were planted on May 2, June 2, July 2 and August 2, at the planting density levels of 20, 40 and 60 plants m^{-2}. The experiment was laid out in randomized complete block design with split plot arrangement having four replications. Twelve combinations of the four planting dates and three plant densities were allotted to main plots and varieties were allotted to sub plots. A sub plot size of 4m x 5m, having 8 rows five meters long was used. Sowing was done in hills and row to row distance of 50 cm and hill to hill distance of 10 cm were used. Two to five seeds per hill were planted and thinning was done to leave 1, 2, 3, plants/hill corresponding to 20, 40, and 60 plants m^{-2} at V2 stage (2nd node with fully developed trifoliate leaf at node above the unifoliate nodes). Normal cultural practices for raising a successful crop were followed uniformly for all the experimental units. The plots were hand weeded at different vegetative stages. Irrigation was applied at weekly interval. Seeds from each planting date, density and variety were harvested, threshed, cleaned and stored properly until the seeds from the last planting date and density were processed. Seeds harvested from all planting dates, density and variety were evaluated for percent protein and oil according to procedures described by the AOAC (1990). Data were statistically analyzed using analysis of variance techniques appropriate for Randomized Complete Block Design with varieties split on combinations of dates of sowing and plant densities and LSD (0.05) test was employed for mean separation when the F-values were significant.

Results and Discussion

The data recorded on protein and oil % age of soybean varieties planted in autumn are reported and discussed below.

Protein Percentage: Statistical analysis of protein percentage data revealed that seed protein concentration was

Table 1: Protein content (%) of soybean varieties as affected by date of sowing and plant density during 1997 and 1998.

Date of Sowing	Variety	Plant density (000) plants ha^{-1}			Mean
		200	400	600	
			Two years average		
			D x V x P		
May 2	Epps	34.9	35.0	34.6	34.8
	William-82	34.0	34.3	35.0	34.4
June 2	Epps	35.1	34.3	35.0	34.8
	William-82	35.4	36.3	35.4	35.7
July 2	Epps	40.0	38.3	36.8	38.4
	William-82	37.3	36.4	35.7	36.5
August 2	Epps	41.6	39.5	37.9	39.7
	William-82	39.9	37.0	36.2	37.7
			D x P		
May 2		34.5	34.6	34.8	34.6 c
June 2		35.2	35.3	35.2	35.3 c
July 2		38.7	37.4	36.3	37.4 b
August 2		40.8	38.3	37.0	38.7 a
			P x V		
	Epps	37.9	36.8	36.1	36.9
	William-82	36.6	36.0	35.6	36.1
Mean		37.3 a	36.4 b	35.8 b	36.5

Table 2: Oil Content (%) of soybean varieties as affected by date of sowing and plant density during 1997 and 1998.

Date of Sowing	Variety	Plant density (000) plants ha^{-1}			Mean
		200	400	600	
			Two years average		
			D x V x P		
May 2	Epps	21.63	20.66	20.33	20.87
	William-82	20.24	20.40	20.39	20.34
June 2	Epps	19.93	20.27	19.67	19.96
	William-82	19.60	19.94	20.24	19.93
July 2	Epps	19.88	19.25	19.05	19.39
	William-82	19.70	19.56	19.56	19.61
August 2	Epps	19.64	19.85	19.54	19.68
	William-82	19.79	19.37	19.31	19.49
			D x P		
May 2		20.93	20.53	20.36	20.61 a
June 2		19.76	20.10	19.96	19.94 b
July 2		19.79	19.41	19.30	19.50 c
August 2		19.72	19.61	19.43	19.58 c
			P x V		
	Epps	20.27 a	20.01 ab	19.65 b	19.97
	William-82	19.83 b	19.82 b	19.87 b	19.84
Mean		20.05	19.91	19.76	19.91

* Means of the same category followed by different letters are significantly different at 0.05 % level of probability using LSD test.

significantly affected by the planting dates (Table 1). Early planted crop produced seeds with minimum protein percentage of 34.6%. Protein percentage increased with delay in planting and late planted crop gave maximum protein percentage of 38.7%. The lower protein percentage from early planted crop may be due to the influence of environmental factors, such as photoperiod and high temperature during maturation of the crop, while the maximum protein percentage from delayed planted crop may be the optimum temperature for protein synthesis during seed development and maturation in October and November. These results are consistent with the findings of Suryavanshi *et al*. (1993), who reported increase in protein percentage of sesame with delay in sowing. Significant differences were observed among the protein concentration of the three plant densities. The lowest plant density at 20 plants m^{-2} produced seed with significantly higher protein percentage as compared to higher plant densities.

No significant difference between cultivars with respect to protein percentage was observed, however Year x variety interaction was significant, which means that the two varieties behaved differently during both years. Epps show more protein percentage than William-82 in 1997 but in 1998 there was non significant difference in protein percentage in the two varieties. Based on the two years average the observed interaction shows that the genotypes interact with environment and affect protein percentage differently in both years.

Oil Percentage: The statistical analysis of the data showed that oil percentage of soybean seed was significantly affected by planting dates (Table 2). Seed harvested from May planted crop had highest oil concentration of 20.61% followed by seed harvested from June planted crop. Delay in planting decreased oil concentration and seed harvested from August planted crop gave minimum percentage of oil. The seed harvested from early planting developed and matured at high temperature, which resulted in more oil concentration than late planted crop. Wolf *et al*. (1982) and Suryavanshi *et al*. (1993) also reported high oil content from seed matured at high temperature compared to 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 enzymes responsible for oil content. No significant difference was observed between different plant populations with respect to oil percentage, however lowest plant density of 20 plants m^{-2} gave higher oil percentage as compared to high plant densities during 1997. An opposite trend was observed in 1998, when higher plant densities of 40 and 60 plants m^{-2} produced seeds with higher oil concentration than seeds from lower plant density. No significant difference between cultivars was observed, however Epps produced seeds with slightly higher oil percentage than William-82. Interaction between plant population x varieties indicate that difference between oil percentages of the two varieties were significant at the lowest and medium plant densities but at highest plant density, the difference between the oil concentration of the two varieties was not significant.

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