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NUTRITIONAL QUALITY AND PRODUCTION OF SOYBEAN LAND RACES AND IMPROVED VARIETIES AS AFFECTED BY PLANTING DATES

ASIM MUHAMMAD[1,*], S. K. KHALIL[1], KHAN BAHADAR MARWAT[2], A.Z. KHAN[1], I.H. KHALIL[3], AMANULLAH[1] AND SHAHNAZ ARIFULLAH[4]

[1]*Department of Agronomy, Faculty of Crop Production Sciences, NWFP Agriculture University*
[2]*Department of Weed Science, Faculty of Crop Protection Sciences, NWFP Agriculture University,*
[3]*Department of Plant Breeding & Genetics, Faculty of Crop Production Sciences, NWFP Agriculture University, Peshawar, Pakistan.*
[4]*Institute of Development Studies, NWFP, Agricultural University, Peshawar, Pakistan*

Abstract

Informations are lacking on nutritional quality of indigenous land races of soybean. Three land races (Kulat brown, Kulat white, Mothi) and two improved varieties (NARC-II, Swat-84) of soybean were sown on April 2, May 2, June 2 and July 2, at New Developmental Farm of NWFP Agricultural University, Peshawar, during 2004-05 and 2005-06 growing season. Planting dates had significantly affected oil and protein content and yield. Maximum protein content (321g kg^{-1}) and protein yield (468 kg ha^{-1}) was recorded for April planting, while maximum oil content (169 g kg^{-1}) and oil yield (244 kg ha^{-1}) was obtained from May planted crop. Maximum oil (17.2 g kg^{-1}) and protein (320 g kg^{-1}) was recorded for variety Swat-84 while higher oil (239 kg ha^{-1}) and protein yield (433 kg ha^{-1}) was given by NARC-II. Improved varieties were superior in nutritional quality as well as nutrient production.

Introduction

Pakistan is chronically deficient in protein and oil. Animal protein is very costly. It is not possible to overcome the oil and protein deficiency gap from the animal sources. Among plants soybean (*Glycine max* (L.) Mirrell) is one of natures most efficient protein producer. Soybean shares more than 50% of the worlds production of high protein meal and more than 30% of the world production of edible oil (Anon., 1986). Soybean produces more usable cheap protein than any other cultivated crop, at least three times more than rice, wheat or maize. Khan (1981) reported that soybean contains about 40% high quality protein which is more than the content of chickpea (19%) mungbean (24%), lentil (25%) and cowpea (24.6%). Mujeb (1984) reported that soybean protein content is even higher than the protein content of animal products like mutton (18.8%), beef (21.3%), chicken (26.2%), fish (17.6%) and eggs (11.9%) (Mujeb, 1984). Soybean is an excellent source of about 20% unsaturated oil. It has fair amounts of calcium, magnesium, phosphorus, copper and zinc (Lee, 1984). Soybean is free of cholesterol and has low levels of sucrose and dextrose (Orthoefer, 1982). Qiu *et al.,* (1991) found increase in oil and protein accumulation in soybean until maturity and had no variation from 36 to 76 days after flowering. However during the final week of senescence, slight decrease in both oil and protein accumulation was observed. Wu & Wei (1992) studied the relationship between fat and protein content in soybean seed and the climatic factors for 9 growth periods. Accumulation of fat and protein in different periods was regulated by changes in temperature, rainfall and day length. Negative correlation between fat and protein content, during late July and early August was observed. Khan (2001) reported inverse relationship between protein and oil percentages with delayed planting. Protein content increased while oil content decreased with delay in planting. Chung *et al.*, (2003) studied the relationship of soybean seed protein with seed oil content and seed yield. It was found that when seed protein was genetically enhanced at the expense of seed oil, the seed yield drastically decreased. Pipolo *et al.*, (2004) reported that temperature from 21 to 29°C did not change oil and protein concentration in soybean seed. Dilution by increased dry matter accumulation in the seed was responsible for much of the variation in oil and protein concentration. Therefore the rate of dry matter accumulation was critical in affecting seed oil and protein concentration. Yin & Vyn (2005) investigated the relationship of oil and protein in seed with yield of soybean. They found that oil content in seed decreased as seed yield was increased. However, the relationship between protein content and seed yield was not significant. Information's about the nutritional quality of indigenous land races of soybean are lacking. In order to explore the nutritional quality of land races in comparison with improved varieties under a wide range of environmental conditions, the present study was initiated.

Materials and Methods

Three indigenous soybean landraces (Kulat brown, Kulat white, Mothi) and two improved soybean varieties (NARC-II, Swat-84) were planted at New Developmental Farm NWFP Agricultural University Peshawar on four planting dates (April 2, May 2, June 2, July 2) during 2004-05 and 2005-06 growing seasons. Kulat brown and Kulat white were procured from Swat, Malakand division and Mothi was acquired from Mansehra, Hazara division of North West Frontier Province (NWFP). NARC-II was an improved variety released by the National Agricultural Research Center, Islamabad and Swat-84 was a selection from Williams-82 released by Agriculture Research Institute, Mingora, Swat. Planting dates were allotted to main while varieties were allotted to sub plots. Each subplot consisted of 3m× 3m having six rows, 3m long and 50cm apart. Seeds were planted at higher seed rate of 95 kg ha^{-1} and thinned at unifoliolate leaf stage (fully developed leaves at unifoliolate nodes) to 5cm between plants, maintaining 20 seedlings per meter row length. A basal recommended dose of 25 kgN and 64 kg P_2O_5 ha^{-1} was applied as diammonium phosphate (DAP) at the time of planting. Weeds were controlled twice through manual weeding and 6 irrigations were applied in all. Each treatment was replicated four times in RCB design with split plot arrangement. After maturity the central rows were harvested, dried, threshed, weighed and seed yield ha^{-1} was determined. Protein content of seeds was determined by Kjeldahl and oil content was determined by Soxhlet fat extractration method as described by AOAC (Anon., 1990). Total protein and oil yield ha^{-1} was computed from seed yield using protein and oil content in each case.

Results and Discussion

Oil content: Planting dates (D), varieties (V) and D x V had significant but year had no significant effect on oil content of soybean (Table 1). Early planted soybean in May (169 g kg^{-1}) and April (165 g kg^{-1}) have higher oil content than June (158 g kg^{-1}) and July (149 g kg^{-1}). Khalil *et al.*, (2000) and Khan (2001) reported that the seed harvested from early planting developed and matured at high temperature, which resulted in more oil concentration than late planted crop. Swat-84 and NARC-II gave higher oil content (171-172 g kg^{-1}) than land races (151-155 g kg^{-1}) maximum oil content (172 g kg^{-1}), followed by NARC-II (171 g kg^{-1}). Minimum oil content (151 g kg^{-1}) was recorded for Kulat brown. Oil content of Kulat white and Mothi was not different than oil content of Kulat brown. Improved varieties demonstrated 1.8 % higher oil content than landraces. Interaction between D x V indicated that oil content in Swat-84 and NARC-II increased when planting was delayed from April to May. However, oil content decreased when planting was delayed to June and July (Fig. 1). Similar pattern was observed for Kulat brown and Kulat white. Mothi demonstrated gradual decrease in oil content when planting was delayed from May to July.

Protein content: Planting dates (D) and varieties (V) had significant effect on protein content (Table 2). Protein content did not change due to years. Maximum protein content (321g kg^{-1}) was recorded in seeds from April planted crop and minimum protein content (303 g kg^{-1}) was recorded in seeds from July planted crop. Protein content was stable and statistically similar for the first three planting dates. However, when planting was delayed to July, significant reduction in protein content was observed. The decrease in protein content with delay planted soybean might be due to the decrease in seed size and yield that might be the possible cause of reduction in protein content of July planted crop. These results are in agreement with those of Khalil *et al.,* (2000) who reported higher protein content in January than August planted crop. However, Bouniols *et al.,* (1998) confirmed negative correlation between oil content and protein content. Schneby & Fehr (1993) found, that early planting dates slightly favoured lower linolenic acid content. Yin & Vyn (2005) reported negative correlation between oil concentration and seed yield but no correlation with protein content. Pipolo *et al.,* (2004) did not find significant difference in oil and protein content within the temperature range from 21-29^{0}C. Maximum protein content (320 g kg^{-1}) was recorded for Swat-84, followed by NARC-II, while minimum protein content (309 g kg^{-1}) was recorded in Kulat brown. Kulat white gave significantly higher protein content than Kulat brown and Mothi and equal to NARC-II. Protein content of improved varieties was significantly higher than landraces. The D x V interaction was not significant.

Oil yield: Variations in oil yield means for planting dates (D), varieties (V) and D x V were significant for the two years average (Table 3). Oil yield was not affected by years. May planting produced the highest oil yield (244 kg ha^{-1}). Oil yield decreased significantly when planting was delayed to June and July. The minimum oil yield (139 kg ha^{-1})) was obtained from July. Oil yield was the function of seed yield and oil content. As seed yield and oil content decreased with delayed planting, the decline in oil yield was logical. NARC-II produced highest oil yield (239 kg ha^{-1}) followed by Swat-84. Minimum oil yield (171 kg ha^{-1}) was given by Kulat brown. Oil yield of improved varieties was 15.7 % greater than the land races. Swat-84 was a lower seed yielder (1245 kg ha^{-1}) than Mothi (1322 kg ha^{-1}) and Kulat white (1281 kg ha^{-1}) but produced greater oil yield (215 kg ha^{-1}) than Mothi (206 kg ha^{-1}) and Kulat white (197 kg ha^{-1}) because of higher oil content (17.2 %) than the later two varieties (15.4 %). The interaction between DxV revealed (Fig. 2) that NARC-II gave maximum oil yield when planted in April. Oil yield decreased when planting was delayed. Similar pattern was observed for Swat-84. In Kulat brown, Kulat white and Mothi, oil yield increased when planting was advanced from April to May. However, oil yield decreased when planting was delayed from May onward.

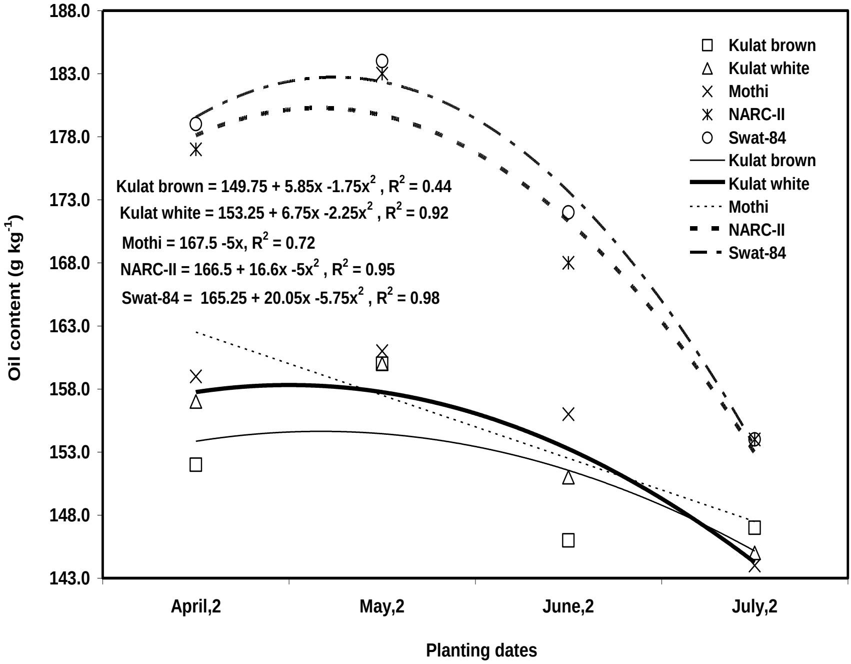

Fig. 1. Oil content (g kg^{-1}) of soybean varieties as affected by planting dates.

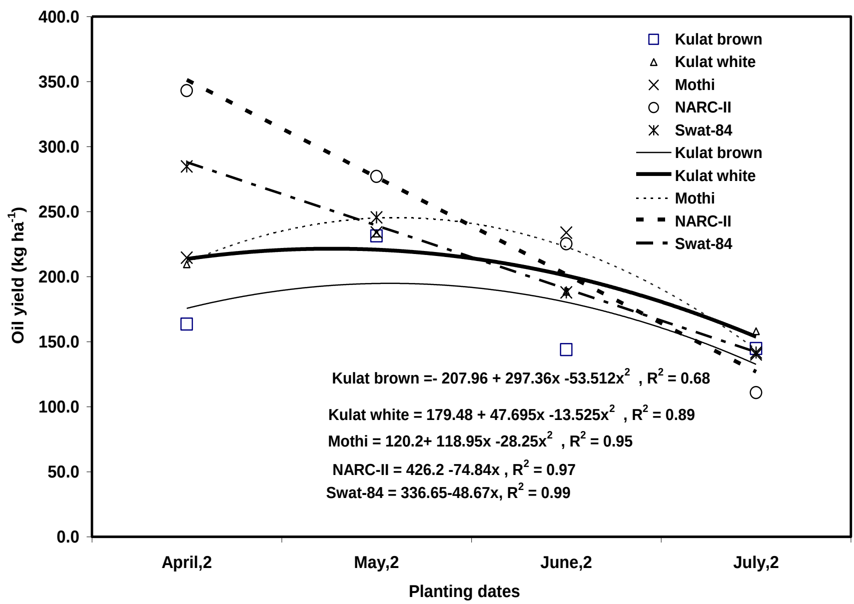

Fig. 2. Oil yield (kg ha^{-1}) on soybean varieties as affected by planting dates.

Table 1. Oil content (g kg^{-1}) of soybean varieties as affected by planting dates.

Varieties	Planting dates				Mean
	April, 2	May, 2	June, 2	July, 2	
Kulat brown	152 e-i	160 def	146 hi	147 ghi	151 b
Kulat white	157 ef	160 def	151 f-i	145 hi	153 b
Mothi	159 def	161 de	156 efg	144 i	155 b
NARC-II	177 abc	183 a	168 cd	154 e-h	171 a
Swat-84	179 ab	184 a	172 bc	154 e-h	172 a
Mean	**165 b**	**169 a**	**158 c**	**149 d**	**-**
Landraces					153
Improved varieties					171
LSD	Planting dates (D)		Varieties (V)	D x V	
0.05	4		3	6.2	

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

Table 2. Protein content (g kg^{-1}) of soybean varieties as affected by planting dates.

Varieties	Planting dates				Mean
	April, 2	May, 2	June, 2	July, 2	
Kulat brown	312	314	313	296	309 c
Kulat white	323	320	319	302	316 b
Mothi	313	316	310	302	310 c
NARC-II	326	325	318	306	319 ab
Swat-84	330	324	317	309	320 a
Mean	321 a	320 a	315 a	303 b	-
Landraces					312
Improved varieties					319
LSD	Planting dates (D)		Varieties (V)	D x V	
0.05	6.6		3.6	NS	

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

Table 3. Oil yield (kg ha^{-1}) of soybean varieties as affected by planting dates.

Varieties	Planting dates				Mean
	April, 2	May, 2	June, 2	July, 2	
Kulat brown	164 fg	231 d	144 gh	145 gh	171 c
Kulat white	210 de	233 d	188 ef	158 fg	197 b
Mothi	215 de	235 d	234 d	140 gh	206 b
NARC-II	343 a	277 bc	225 de	111 h	239 a
Swat-84	285 b	246 cd	188 ef	142 gh	215 b
Mean	243 a	244 a	196 b	139 c	
Landraces					191
Improved varieties					227
LSD	Planting dates (D)		Varieties (V)	D x V	
0.05	20.5		19.3	38.6	

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

Table 4. Protein yield (kg ha^{-1}) of soybean varieties as affected by planting dates.

Varieties	Planting dates				Mean
	April, 2	May, 2	June, 2	July, 2	
Kulat brown	322 e	468 bc	308 e	290 e	347 b
Kulat white	434 c	464 bc	398 cd	327 de	406 a
Mothi	423 c	449 c	467 bc	294 e	408 a
NARC-II	633 a	468 bc	425 c	206 f	433 a
Swat-84	526 b	443 c	347 de	274 ef	398 a
Mean	468 a	459 a	389 b	278 c	-
Landraces					387
Improved varieties					415
LSD	Planting dates (D)		Varieties (V)	D x V	
0.05	39.5		37.0	74.0	

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

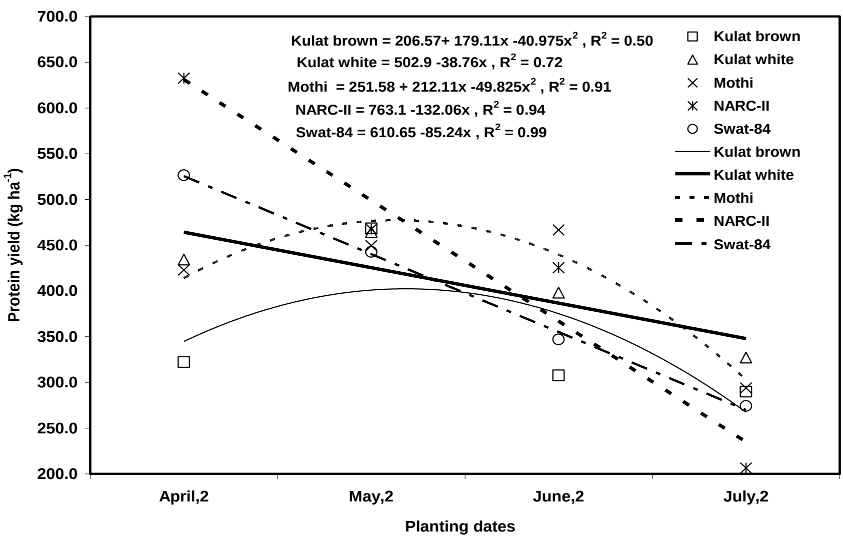

Fig. 3. Protein yield (kg ha^{-1}) of soybean varieties as affected by planting dates.

Protein yield: Significant differences were observed in protein yield means among planting dates (D), varieties (V) and D x V interaction for the two years average (Table 4). Differences in protein yield due to years were not significant. Highest protein yield (468 kg ha^{-1}) was observed in April planted crop, while minimum protein yield (278 kg ha^{-1}) was observed in July planted crop. Protein yield for April (468 kg ha^{-1}) and May (459 kg ha^{-1}) planting was similar and significantly higher than protein yield of June (389 kg ha^{-1}) and July (278 kg ha^{-1}) planted crops. Protein yield from the early two planting dates (April and May) was 28 % higher than protein yield of the later two planting dates, (June and July). The decline in total protein yield from April to July planting coincided with the decline in protein content and seed yield. NARC-II produced maximum protein yield (433 kg ha^{-1}), while Kulat brown produced the lowest protein yield (347 kg ha^{-1}). Protein yield of Kulat white, Mothi and Swat-84 did not show significant differences from protein yield of NARC-II. Protein yield of improved varieties was 6.8 % higher than land races. The lowest protein yield of Kulat brown could be due to its low seed yield as well as protein content. Swat-84 being the second lowest seed yielder (1245 kg ha^{-1}), has been included with high protein yielder varieties, because of its high protein content (32 %). DxV interaction revealed that NARC-II produced maximum protein when planted in April (Fig. 3). Protein yield decreased when planting was delayed. Similar pattern was observed for Swat-84. In Mothi, Kulat white and Kulat brown, protein yield increased when planting advanced from April to May and then decreased with further delay in planting.

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