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Transplanting of Soybean Cultivars after Rice Harvesting in the North of Iran

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ABSTRACT

Intercropping of agricultural crops is one of the considerable approaches to increase agricultural efficiency. To optimize use of Guilan (Northern Province of Iran) rice lands in time unit, sequential cropping of rice and soybean was assessed. In this experiment, rice and soybean were planted as a main crop and second crop, respectively. Soybean seed sowing and production of soybean transplants carried out before rice harvesting. Immediately after rice harvesting, transplants of 7 cultivars of soybean, including; SRF, M_{12} ،M_4 ،Williams ،L_{11} ،Clark and Pashm-baqala, planted in related blocks. The experiment was carried out by using randomized complete block design in three replications. Vegetative and reproductive stages of soybean studied from sowing to harvesting date. Based on results, maximum died transplants, least seed yield, lowest plant height, maximum chlorosis due to bad drainage and shortest first pod per plant related to SRF cultivar. The safest transplants in the nursery were related to William's cultivar (with 96% safe plants). Plant height, lateral branches number and seed yield had significant difference at $p > 1\%$, while height of first pod and seed numbers per plant had significant difference at $p > 5\%$ between soybean cultivars. Results showed that Pashm-baqala and L_{11} cultivars had maximum seed yield i.e. 194.5 and 196.1 g/m^2, respectively. SRF had the lowest yield. In conclusion, the high yield was related to Pashm-baqala and L11 whereas SRF produced the least yield.

Key Words: Sequential cropping; Rice; Transplanting; Soybean

INTRODUCTION

Rice is the world's most important staple food crop. More than four-fifths of the world's rice is produced and consumed by small-scale farmers in low-income and developing countries. More than half of the world's population relies on rice as the major daily source of calories and protein. The amount of rice consumed by each of these people ranges from 100 to 240 kg per year, according to FAO (FAO, 2002). An average revenue operation rice land of Gilan Province (Northern State of Iran) is 0.8 ha, which can not provide farmer expenditures (Darvish, 2002). About 25 - 40% of soybean production allocates to its intercropping after cereals in USA. Soybean (*Glycine max* L.) intercropping is also current in Gorgan and Mazandaran provinces in Iran (Khadem, 1998).

Sequential cropping of rice-soybean is done in heavy texture soils of rice lands in Asia (Latifi, 1995). Soybean is a leguminous plant, which improves soil and it can grow in wide range of soils. It is sensitive to photoperiod (Heatherriy, 1993; Arshi, 2000). Sharafi (1996) tested soybean direct planting after rice harvesting and found that soybeans enter to reproductive phase before vegetative stage completion due to regional short days. It is not produced any crop due to lack of enough time to complete of pods development. There is not any report about soybean transplanting after rice harvesting. We studied transplanting of soybean after rice harvesting to remove diverse effect of short days on growth completion of soybean pods.

MATERIALS AND METHODS

The test was conducted at paddy field of Iranian rice research institute, Rasht, in 2004. Rice seedlings transplanted late April and harvested on August 16 and field was prepared again to transplant soybeans. It is prepared shallow drainages with 15 cm deep and 150 cm distance. Early cultivar rice i.e. line 206 is used because of summer planting of soybean and necessity of enough time to ripen soybean. The experiment was conducted as a randomized complete block design with three replications. Seven soybean cultivars viz., SRF, M_{12}, M_4, Williams, L_{11}, Clark and Pashm-baqala (a native cultivar) planted in 1.58 x 5 m^2 plots with thirty plants per one meter square, with plan to plant distance of 6.6 cm intervals and row to row distance of 50 cm (Latifi, 1995).

Some traits such as, vegetative and reproductive growth of soybean cultivars (in nursery & main field), seed yield, number of days to flowering (R_1) and to complete seed ripening (R_8), plant height, first pod height from ground, pod numbers per plant, lateral branch numbers, seed numbers per plant, pod height, pod numbers per node, un-filled pods % and seed numbers per pod are assessed. Died transplants % are also studied in nursery and transplanting time. Height of plant is obtained by measuring of crown to last nodes per plant. Soybean development is characterized by two distinct growth phases. The first is the vegetative stages (V) that cover development from emergence through flowering. The second is the reproductive (R) stages from flowering through maturation. These stages, which we studied are (Ashley & Ethridje, 1988; Rupe *et al*., 1999;

McWilliams *et al*., 2005):

Vegetative stages.

VE (emergence)
VC (cotyledon stage)
V1 (first trifoliolate)
V2 (second trifoliolate)
V3 (third trifoliolate)
V_4 (fourth trifoliolate)
V_5 (fifth trifoliolate)
V6 (flowering will soon start).

Reproductive stages.

R1 (beginning bloom, first flower) = V_7 - V_{10}
R2 (full bloom) = V_8 - V_{12}
R3 (beginning pod) = V_{11} - V_{18}
R4 (full pod) = V_{13} – V_{20}
R5 (beginning seed set) = V_{15} – V_{23}
R6 (full size seed) = V_{16} – V_{25}
R7 (beginning maturity).
R8 (full maturity, 95% of pods on the plant are mature).

Nursery preparing to sow soybean seeds was conducted at rice heading stage. Rice harvested in complete ripening stage and then rice land is prepared to transplant soybeans. Each cultivar planted in three rows and three replicates. Soybeans harvested in full ripening stage and data analyzed using MSTATC statistical software.

RESULTS AND DISCUSSION

Assessment of soybean vegetative and reproductive stages. Growth and development stages studied in two periods, first from soybean seeds sowing in nursery to seedlings transplanting and second from planting in main lands to maturity stage (Tables I & II). All soybean cultivars seeds sowed at July 11 and all of them got to V_E, V_C and V_1 stages 8, 11 and 17 days following seed sowing respectively (Table I). Some early cultivars such as SRF and M_{12} got to R_1V_2 stage after 24 days, while others were in V_2 stage. L_{11}, Clark and Pashm-baqala were in vegetative stage after about one month but SRF, M_{12} and Williams entered to reproductive phase.

All soybean cultivars entered to reproductive phase at transplanting time (27 August) except Pashm-baqala. Williams and L_{11} cultivars had maximum vegetative growth (R_7) and L_{11} and SRF had the highest reproductive growth (R_4) (Table I). SRF, M_{12}, M_4 and Williams' plants matured completely at R_8V_{12}, R_8V_{10}, R_8V_9 and R_8V_{10}, respectively and all of them harvested at October 25 except SRF. While L_{11}, Clark and Pashm-baqala Matured fully at R_8V_{15}, R_8V_{10} and R_8V_{12} stages, respectively (Table II).

Investigation of experimental traits. Died transplants % obtained at transferring time. Safe seedlings % is shown in Fig. 1. It should be kept in mind that because of seed sowing in summer, irrigation and water source were important factors and the success rate for this operation is very low without these factors. Some seedlings of SRF turned yellow and died. Results showed that SRF is sensitive to flooding.

Table I. Vegetative and reproductive stages of soybean cultivars in nursery

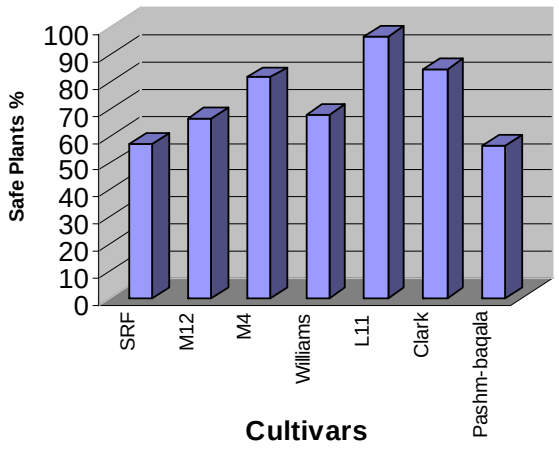
Soybean cultivars		V7 (Pashm-baqala)	V6 (Clark)	V5 (L_{11})	V4 (Williams)	V3 (M_4)	V2 (M_{12})	V1 (SRF)
Date								
month	day	Vegetative and Reproductive stages						
7	11	Sowing date						
7	19	V_E	V_E	V_E	V_E	V_E	V_E	V_E
7	21	V_C	V_C	V_C	V_C	V_C	V_C	V_C
7	27	V_1	V_1	V_1	V_1	V_1	V_1	V_1
8	04	V_2	V_2	V_2	V_2	V_2	R_1V_2	R_1 V_2
8	06	V_2	V_2	V_3	R_1 V_2	V_2	R_1V_3	R_2 V_3
8	09	V_3	V_3	R_1 V_4	R_2 V_4	R_1V_2	R_2V_3	R_2 V_4
8	14	V_4	R_1 V_4	R_2 V_5	R_2 V_5	R_2V_3	R_2V_3	R_3 V_4
8	19	V_5	R_2 V_5	R_3 V_6	R_3 V_6	R_3V_4	R_3V_4	R_4 V_5
8	25	V_5	R_3 V_6	R_4 V_7	R_3 V_7	R_3V_5	R_3V_5	R_4 V_5
8	27	Transplanting						

Table II. Vegetative and Reproductive stages of Soybean cultivars in Field

Soybean cultivars		V7 (Pashm-baqala)	V6 (Clark)	V5 (L_{11})	V4 (Williams)	V3 (M_4)	V2 (M_{12})	V1 (SRF)
Date								
month	day	Vegetative and Reproductive stages						
8	27	Transplanting						
8	30	V_5	R_3 V_6	R_4 V_8	R_3 V_7	R_3 V_5	R_3 V_5	R_5 V_5
9	02	V_6	R_4 V_6	R_5 V_8	R_4 V_7	R_3V5	R_3 V_6	R_5 V_6
9	05	R_1 V_7	R_4 V_7	R_5 V_8	R_5 V_7	R_3 V_5	R_4 V_7	R_6 V_7
9	11	R_1 V_8	R_4 V_8	R_5 V_9	R_5 V_7	R_3 V_6	R_4 V_8	R_6 V_7
9	19	R_2 V_9	R_5 V_8	R_5 V_9	R_6 V_7	R_5 V_7	R_4 V_9	R_7 V_8
9	24	R_3V_{10}	R_6 V_9	R_6 V_9	R_6 V_8	R_5 V_8	R_5 V_9	R_7 V_9
10	06	R_4V_{10}	R_7 V_{10}	R_7 V_9	R_7 V_9	R_6 7_8	R_6V_{10}	R_8V_{10}
10	13	R_5V_{11}	R_8 V_{10}	R_8 V_9	R_8 V_{10}	R_7 V_9	R_7V_{10}	R_8V_{11}
10	20	R_6V_{11}	R_8 V_{10}	R_8V_{10}	R_8 V_{10}	R_8 V_9	R_8V_{10}	Har.
10	25	R_7V_{12}	Har.	Har.	Har.	Har.	Har.	
11	08	Har.						

Har.= Harvesting

Fig. 1. Safe soybean seedlings percent at transferring time



Therefore, shallow drainage is necessary to sequential cropping in rice lands (Yazdani, 2001). Since soybean have high rhizosphere oxidation ability (Rajujk, 2000) it can tolerate flooding condition, but shallow drainage was

necessary in sequential cropping soybean after rice. Plant height and first pod height had significant difference at 1% and 5% level in soybean cultivars, respectively (Table III). Data means comparison showed that highest plant height related to Williams and L_{11} cultivars, while SRF and M4 had lowest height. Some traits such as pod numbers per plant and seed numbers per pod had non-significant difference. Native cultivar Pashm-baqala had large amount lateral branches, while L_{11} did not have any lateral branch. The large amount of seeds related to Williams and L_{11} cultivars (Table III). In conclusion, the high yield related to Pashm-baqala and L_{11} and SRF produced the least yield (Table III). None of the cultivars had un-filled pods.

Table III. Means comparison of traits in soybean cultivars

Traits Cultivars	Plant height(cm)	First pod height (cm)	Lateral branch No	Seed No per plant	Seed yield (g/m^2)
SRF	32.7b*	11.3c	1.7ab	31abc	25.9d
M_{12}	42ab	17c	0.7bc	25.3bc	115.1bc
M_4	34.3b	15c	1abc	24 c	93.4c
Williams	64.7a	14.7c	1.3ab	35a	165ab
L_{11}	63a	24b	0c	35a	196.1a
Clark	47ab	16.7c	1abc	27bc	157.1ab
Pashm-baqala	55ab	31a	2a	32abc	194.5a

*: Values followed by the same letters are not significantly different according to Duncan's Multiple Range Test ($p<0.05$)

Results of growth and development analysis revealed that about all soybean cultivars have ecologically and economically agreements to plant in Guilan province as sequential cropping. Since, we can plant all cultivars in this area. In this experiment, SRF and Pashm-baqala had the maximum amount of died transplants in nursery. Therefore these cultivars can not tolerate nursery condition well. Soybean plants have special sensitivity to water stress at flowering, pollination and seed filling stages. Williams cultivar had the lowest died transplants in the nursery and about 96% safe seedlings transferred to field. Drainage situation did not show negative effect on the cultivars except SRF.

Finally, shallow drainage is a necessity to sequential cropping specially soybean in rice lands. This approved in our experiment and according to Yazdani (2001).

Approximately all cultivars filled pods and there were averagely 2 - 3 seeds per pod. These results revealed that climatic condition of Guilan province is suitable to complete reproductive stage of soybean after rice harvesting. Since soybean is an agreeable plant to rice field soils and it has different early to late cultivars, therefore it is an ideal plant to sequential cropping after rice (Raju, 2000). Our results confirmed this opinion. Pashm-baqala and L_{11} had the highest yield, but L_{11} had the least died seedlings in nursery too. Therefore, L_{11} can be suggested as a good soybean cultivar for planting after rice harvest. While SRF had the least yield as well as highest died seedlings, consequently this cultivar does not suggest to sequential cropping.

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