FORMATION OF TUBERS IN THE ROOTS OF SOME SOYBEAN VARIETIES, GENERAL AND ACTIVE SYMBIOSIS

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Abstract. *The study investigated the effects of planting dates on nodule formation and symbiotic activity in two soybean varieties, "Orzu" and "Oyjamol", grown on irrigated meadow saz-alluvial soils in the Fergana region of Uzbekistan from 2018 to 2020. Nodule formation occurred 7-11 days after germination, with leghemoglobin appearing 2 days later, indicating active symbiosis. The transition from leghemoglobin to choleglobin, marking the end of active symbiosis, varied between varieties and planting dates. Delayed planting shortened the duration of both total and active symbiosis. The "Orzu" variety exhibited longer total and active symbiosis compared to "Oyjamol". Total symbiosis ranged from 65 to 85 days, while active symbiosis lasted 57 to 77 days. The study highlights the importance of planting date and variety selection in optimizing symbiotic nitrogen fixation in soybeans, with earlier planting favoring longer periods of active symbiosis. These findings can inform management practices to maximize the benefits of biological nitrogen fixation in soybean production systems.*

Kew words: *Fergana region, Orzu variety, Oyjamol variety, symbiosis, Uzbekistan.*

INTRODUCTION

Soybeans are the most popular means of getting rid of protein-calorie deficits for humans, because animal protein is not tolerated by many people and is somewhat difficult to digest [Fabiyi, 2006]. The formation of tubers in the shade is different compared to other plants. Several studies have been conducted on the formation of tubers in this species.

Tuber formation occurs 10-14 days after germination, and after 4-7 days, leghemoglobin (Lb) - a red pigment appears in them, which supplies energy centers with oxygen and helps release energy to fix nitrogen from the air. When the grains are fully mature, the nodules begin to turn green and legmoglobin is converted to choleglobin (Chb). At the end of the growing season, the tubers die [Dzhakusko 2006].

According to I.Ya. Shishkhaev (2009) reported that in all planting periods, tubers formed 9-14 days after germination. The appearance of leghemoglobin (Lb) in tillers coincided with the third trifoliate phase. In years with good moisture, the transition of leghemoglobin to choleglobin (Xb) occurred during grain filling, and under conditions of moisture deficiency, during pod formation and the beginning of grain filling (figure 1). The duration of active symbiosis depends on the meteorological conditions of the year, duration of planting, and duration of the growing season of soybean varieties [Shishkhaev, 2009]. In studies conducted by B. B. Djakusko (2006), it was found that the duration of the total symbiosis was an average of 82 days for the "Svetlaya" variety, of which the active days were 73, for the Oyjamol variety, 92 and 83 days, respectively. [Dzhakusko, 2006].

Figure 1. Appearance of leghemoglobin status in tubers

In the experiments of the U.G. Zuzuev (2011) reported that the maximum mass of active nodules corresponded to the pod formation period, after which this indicator decreased. During the period of complete filling of grains, the mass of active nodules decreased by 45% in the "Okskaya" variety and 60% in the "Renta" variety compared to their total mass [Zuzuev, 2011]. In recent years, the photosynthetic potential of some soybean varieties has been studied on the example of Fergana region [Мамуров, Санакулов 2021a. 2021b].

MATERIAL AND METHODS

Field research was conducted at the "Melikozi Ota" farm, Fergana Region, Uzbekistan, from 2018 to 2020. Field research was conducted according to the standards presented in the literature [Methods of conducting... 2014]. Two varieties of soybean were selected for this study, and the effect of bacterial fertilizers (nitragin) were studied. The selected varieties were as follows:

"Orzu" variety. It was created by the scientists of the Rice Research Institute of Uzbekistan N. Tolaganov, A. Rakhmanov, and A. Sirimov by the method of individual selection. The growing season last is for 95–100 days The plant is 90–100 cm tall. The variety can yield 20–25 t/ha under favorable conditions.

"Oyjamol" variety It was created by M. Mannopova, R. Siddikov, B. Mirzaakhmedov scientists of the Research Institute of Cereals and Legumes. The growth period was 90-98 days, and the plant height was 76-85 cm. Under favorable conditions, 31-35 tons/ha of grain yield can be obtained from this variety.

Results and discussion

In a study carried out in 2018 on irrigated meadow saz-alluvial soils in the Fergana region, soybean lawns germinated within 4-5 days, and the formation of tubers in both varieties was documented on the 10th VI (control) planting period on the 22nd VI or 7 days after germination. 2 days later (24.VI) it was found that leghemoglobin appeared in the tubers, that is, their color changed to pink-red when they were cut. A difference between the varieties was observed in the transition of tuganaks from the leghemoglobin state to the choleglobin state. After 9-10 days, it was noted that the tubers died.

In this situation, tuber the emergence of tubers occurred on the 5th day after grass germination (29.VI) when the seeds were sown at 20. VI. The symbiotic activity of the

tubers was manifested after 2 days, and it was noted that the transition from the leghemoglobin state to the choleglobin state was 1 day longer in the Orzu variety and 5 days longer in the Oyjamol variety than in the 10. VI (control) planting period.

Soybean seeds were planted in 01. VII, the formation of nodules and appearance of leghemoglobin were the same as those on the 10. VI (control), and 20. VI sowing dates, but the symbiosis activity was slightly different, that is, 72 days in the Orzu variety compared with 10. VI (Control) option. It was found that it was 64 days longer in the Oyjamol variety or 2 days longer than in the 10. VI (control) variant if it was reduced to 4 days. Therefore, the symbiotic activity of each variety is a characteristic of the variety, and planting duration has a significant effect on this activity. The general trends in the appearance of tubers and leghemoglobin were maintained during the delayed planting period (10. VII), but the symbiotic activity was somewhat shorter; that is, the Orzu variety was 12 days shorter than the 10. VI (control) planting period, and the Oyjamol variety was five days shorter than that in the 10. VI (control) planting period. (Table 1). The same situation was repeated in the following years of the experiment (2019-2020).

Table 1

Effects of planting dates on nodule formation and death in soybean cultivars (2018)
Note: period duration in the figure, calendar dates in the denominator; *Lb - leghemoglobin, Xb - choleglobin

№	Planting period	Variates	Tubers formation	The emergence of Lb *	from Lb to XB change*	Dies of Tubers
1	10.VI (control)	Orzu (control)	12/22.VI	2/14.VI	76/24.VIII	9/6.IX
2		Oyjamol	12/22.VI	2/24.VI	62/14.VIII	9/23.VIII
3	20.VI	Orzu (control)	9/29.VI	2/01.VII	77/03.IX	4/7.IX
4		Oyjamol	9/29.VI	2/01.VII	67/25.VIII	4/29.VIII
5	01.VI I	Orzu (control)	10/11.VII	2/13.VII	72/10.IX	6/16.IX
6		Oyjamol	10/11.VII	2/13.VII	64/04.IX	6/10.IX
7	10.VI I	Orzu (control)	11/21.VII	2/23.VII	64/14.IX	8/22.IX
8		Oyjamol	11/21.VII	2/23.VII	57/06.IX	8/14.IX

General symbiosis, active symbiosis, and other indicators were determined based on the analysis of the formation of follicles, leghemoglobin status, transition to choleglobin status, and death of follicles. In this experiment, the general symbiosis of soybean varieties

ranged from 65 to 85 days, and active symbiosis ranged from 57 to 77 days. It was found that general and active symbiosis decreased with postponement of planting time (Figure 2). Notably, the Orzu variety was superior to the Oyjamol variety in terms of both total and active symbiosis (Table 2).

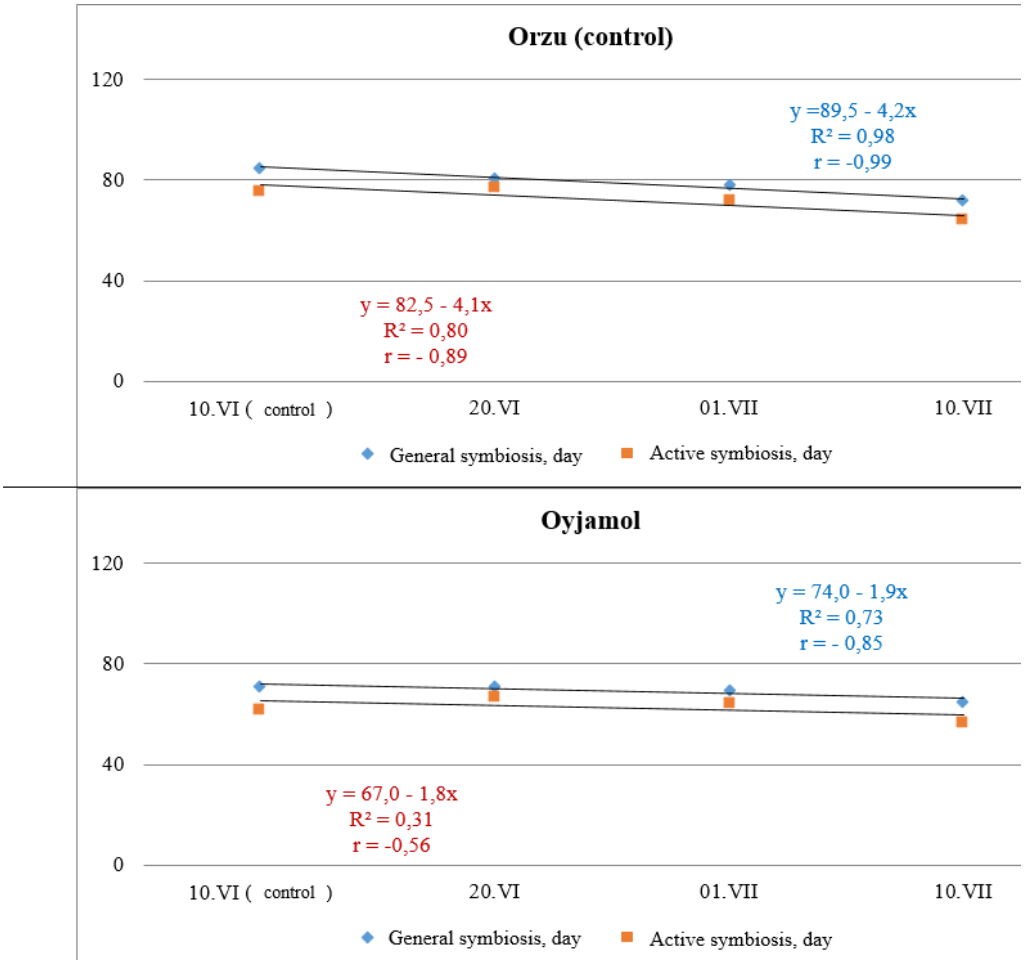

Figure 2. Dependence of general and active symbiosis in soybean varieties on planting dates (2018-2020)

During the mathematical-statistical analysis of the dependence of general and active symbiosis on planting dates in soybean varieties, it was found that the regression equation of dependence in both varieties is subject to y = a – bx and is straight-line according to its expression and inverse according to its direction. In this case, the coefficients of determination (R2 › 0.7) and correlation (r › - 0.7) were found to be high in the Orzu (control) variety, while the strength of the relationship between active symbiosis and planting dates in the Oyjamol variety was slightly weaker than that of the Orzu (control) variety, that is, the determination coefficient R^2 = 0.31 and correlation coefficient r = -0.56.

The total symbiosis potential (TSP) and active symbiosis potential (ASP) were found to vary across experimental variants, corresponding to general and active symbiosis. TSP was 7970-4249 kg/ha*day in the Orzu variety, while it was 7465-4571 kg/ha*day in the Oyjamol variety. Similar to the variation in TSP, ASP also varied with planting dates across cultivars. ASP was found to–7675-3777 kg/ha*day in the Orzu

variety and 7044-4008 kg/ha*day in the Oyjamol variety. Experimental analysis revealed that TSP and ASP in both cultivars were highest when seeds were sown at 20.VI, which is superior to the other sowing dates.

Table 2

Effect of planting dates on total and active symbiosis activity of soybean cultivars (2018)

	Planting period	Variates	General symbiosis, day	Active symbiosis, day	TSP, kg/ha*day	ASP, kg/ha*day	Weight of tubers, kg/ha
	10. VI (control)	Orzu (control)	85	76	6788	6069	79,86
		Oyjamol	71	62	6496	5672	91,49
	20. VI	Orzu (control)	81	77	7970	7576	98,39
5		Oyjamol	71	67	7465	7044	105,14
	01. VII	Orzu (control)	78	72	4575	4223	58,65
		Oyjamol	70	64	6162	5634	88,03
	10. VII	Orzu (control)	72	64	4249	3777	59,01
		Oyjamol	65	57	4571	4008	70,32

The active symbiosis potential (ASP) also depends on the duration of the growing season. In the studies conducted by U.A. Delaev (2012), it was found that the vegetation period for the Okskaya variety was 90 days on average in four years, and 106 days for Renta, while the ASP for the Okskaya variety was 1.8 times less than the Renta variety [Delaev, 2012].

As a result of the conducted studies, the mass of tubers in the experimental variants (2018) changed from 59.01 kg/ha to 105.14 kg/ha. The highest indicator of the mass of tubers was observed in variants planted at 20. VI, and it was 98.39 kg/ha in Orzu variety and 105.14 kg/ha in Oyjamol variety. An analogous situation was repeated in the remaining years of the experiment.

CONCLUSION

The formation of nodules on the tubers of soybean varieties was observed 5-7 days after the germination of grasses, and after 2 days, they become active. Although the

symbiotic activity was more continuous in the Orzu variety compared to the Oyjamol variety, it was found that the Oyjamol variety (105.14 kg/ha) accumulated 6.75 kg/ha more nodule mass than the Orzu variety (98.39 kg/ha). If the planting date was moved earlier or later than 20.VI, the TSP and ASP indicators are significantly reduced and this has a negative effect on biological nitrogen.

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