Phenological Response to Rising Soil Temperature During Vegetative Growth in Soybean

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地温上昇がダイズの発育ステージ及ぼす影響

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Rising atmospheric temperature under global warming is generally known to have effect on crop production through reflecting the temperature of shoot meristem. We evaluated the effect of root-zone temperature on soybean phenological development at the identical temperature of the shoot meristem.

Materials and Methods

Two years field experiments were conducted using Harsoy (Dt1dt2), indeterminate wild soybean type with three different plastic mulch colors to control soil temperature under field condition. Green, black and white colors of plastic mulch with 0.2 mm thickness and 2.1 m width (Okura Industrial Co. Ltd., Japan) was used to give temperature of high, medium and low soil temperatures, respectively, plus no mulch as control in normal and late season soybean (May and June). Radiation transmittance under green mulch is 50% and less than 1% for white and black mulch (referred to Okura Industrial Co. Ltd., Japan). Planting was done at a spacing of 0.75 ×0.25m with three replications, giving total plot areas of 20.9 × 16.8m and 8.3 × 18m for normal and late sowing respectively. Data was collected on vegetative and reproductive development on six plants in each plot at 2-3 days interval. Mean soil temperature during vegetative stages (sowing – R1) was 4 – 6℃ greater under green versus white mulch and control (23/25℃ versus 19/22℃ for normal/late sowing) and 1-2℃ greater from sowing to physiological maturity (23/22℃ versus 21/21℃ for normal/late sowing).

Results and Discussion

Increase in soil temperature accelerated vegetative development in soybean resulting in an addition of 1- 2 node numbers in medium and high soil temperature treatments compare to control. Number of days from sowing to the beginning of flowering (R1) significantly decrease under higher soil temperature for both normal and late season soybean. As a result of the significant effect of higher soil temperature during vegetative stage, significant reduction in the number of days from R1 to R6 (seed filling), R6-R8 (physiological maturity) was observed, with also greater magnitude of reduction during the period of sowing to R8. The period from sowing to R1, R1 to R6, R6 to R8 and sowing to R8 was 1 – 3, 4 – 9, 6 – 9 and 5 – 16 days earlier under higher soil temperature respectively in normal and late seasons. Across years, 1℃ increase in soil temperature decreases the period of sowing to R1 by 0.5 – 0.9 day, with 5 – 6 days decrease from sowing to R8, indicating that future increases in soil temperature under global warming can faster phenological development in soybean.

Conclusions

Higher root-zone temperature during vegetative stages significantly affects soybean phenological development even though the shoot meristem is aboveground. The effect of root-zone temperature

was carried over to physiological maturity by 4 – 6 days earlier per 1℃ .

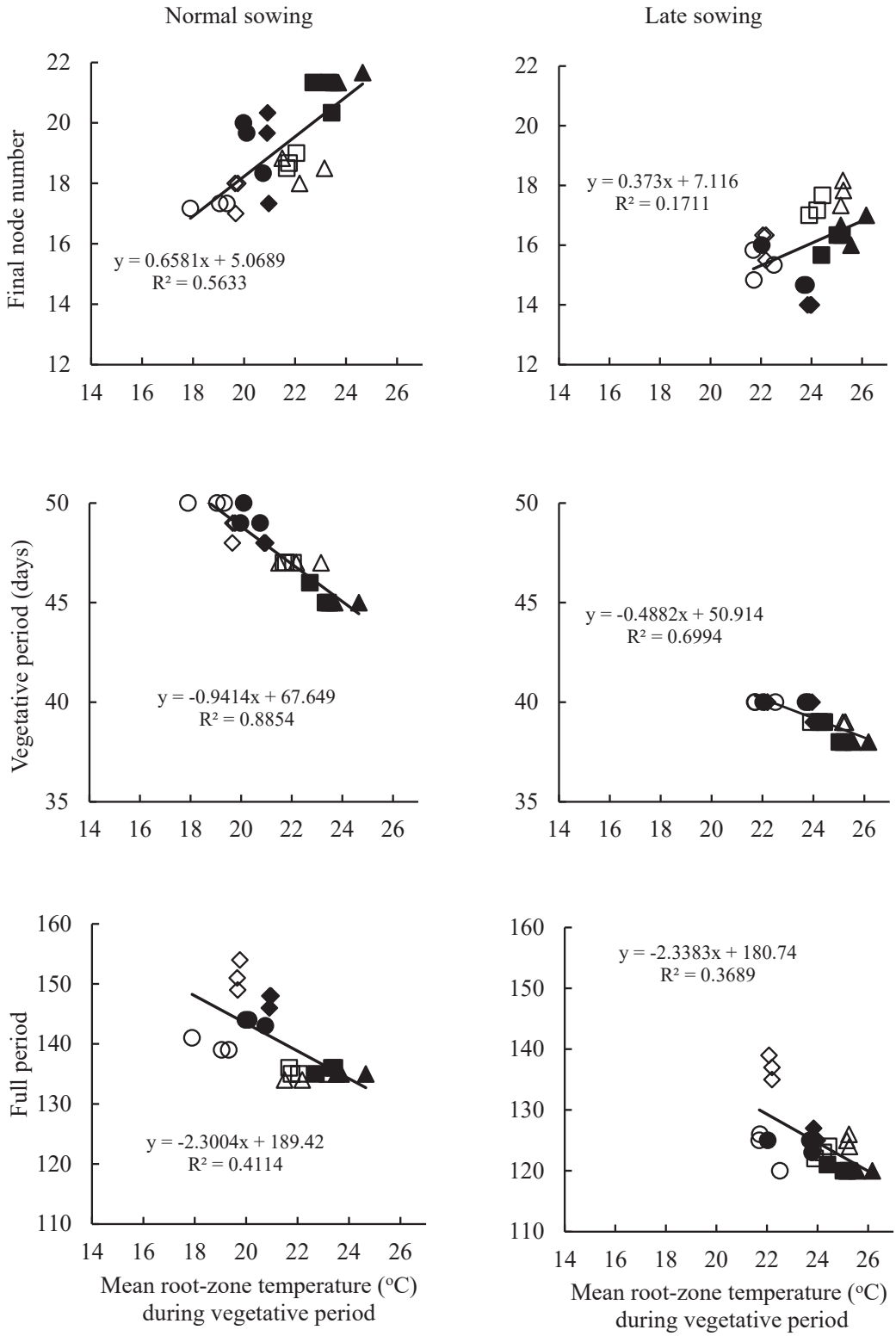

Figure 1. Relationship of vegetative (node number), and reproductive development of soybean against mean root-zone temperatures during vegetative period in 2019 and 2020. Control-CT_s (◇), (◆) ; Low-LT_s (○), (●) ; Medium-MT_s (□), (■) ; High temperatures-HT_s (△), (▲). open symbol 2019, closed symbol 2020.