WHY HARVEST INDEX AND YIELD ARE INVERSELY RELATED IN SOYBEAN

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ABSTRACT

ANALYSIS OF DATA COLLECTED ACROSS A WIDE RANGE OF ENVIRONMENTS DEMONSTRATED THAT THE INVERSE RELATIONSHIP OF YIELD WITH HARVEST INDEX (HI) ULTIMATELY RESULTED FROM AN INVERSE RELATIONSHIP OF TOTAL DRY MATTER AT R5 [TDM(R5)] WITH NODE PRODUCTION EFFICIENCY [NODE NO. PER G TDM(R5)]. YIELD COMPONENT COMPENSATION AT ANY LEVEL OF YIELD FORMATION DID NOT EXPLAIN WHY YIELD AND HI WERE INVERSELY RELATED. RESULTS INDICATED THAT YIELD RESPONSES TO INCREASED TDM(R5) COULD BE GREATER IF NODE PRODUCTION EFFICIENCY WERE GREATER.

INTRODUCTION

HARVEST INDEX (HI) AND YIELD ARE INVERESLY RELATED FOR SOYBEAN GROWTH ACROSS A RANGE OF ENVIRONMENTS (FIG.1).

- THIS INVERSE RELATIONSHIP RESULTS FROM AN ASYMPTOTIC RELATIONSHIP OF YIELD WITH TOTAL DRY MATTER AT R5 [TDM(R5)] (Fig. 1).
- CHANGES IN TDM(R5) AFFECTED YIELD THROUGH CHANGES IN NODE, POD AND SEED NUMBERS, ALL OF WHICH RESPOND TO TDM(R5) IN THE SAME ASYMPTOTIC RELATIONSHIP AS DOES YIELD.

HYPOTHESES TO EXPLAIN THE INVERSE RELATIONSHIP BETWEEN YIELD AND HI

- REDUCED NODE PRODUCTION EFFICIENCY [NODE NO. PER GRAM TDM(R5)] AS TDM(R5) INCREASES.
- COMPENSATION BETWEEN COMPLEMENTARY YIELD COMPONENTS AT ANY OF THE FOUR LEVELS OF YIELD FORMATION:

1. PRIMARY LEVEL: SEED NUMBER PER AREA AND SEED SIZE AFFECTING YIELD.
2. SECONDARY LEVEL: SEED PER POD AND POD NUMBER PER AREA AFFECTING SEED NUMBER PER AREA.
3. TERTIARY LEVEL: POD PER REPRODUCTIVE NODE (NODE BEARING AT LEAST ONE POD) AND REPRODUCTIVE NODE NUMBER PER AREA AFFECTING POD NUMBER PER AREA.
4. QUATERNARY LEVEL: NODE NUMBER PER AREA AND PERCENTAGE REPRODUCTIVE NODES (% OF NODES BECOMING REPRODUCTIVE) AFFECTING REPRODUCTIVE NODE NUMBER PER AREA.

RATIONALE

- EXPLANATION FOR THE INVERSE RELATIONSHIP BETWEEN YIELD AND HI MAY HELP IDENTIFY YIELD LIMITING PROCESSES.
- THIS WOULD ALLOW FOR GREATER YIELD POTENTIAL AS TDM (R5) INCREASES.

OBJECTIVE

DETERMINE IF THE INVERSE RELATIONSHIP BETWEEN YIELD AND HI IS DUE TO :

- INVERSE RELATIONSHIP BETWEEN TDM(R5) AND NODE PRODCUTION EFFICIENCY.
- YIELD COMPENSATION BETWEEN COMPLEMENTARY YIELD COMPONENTS.

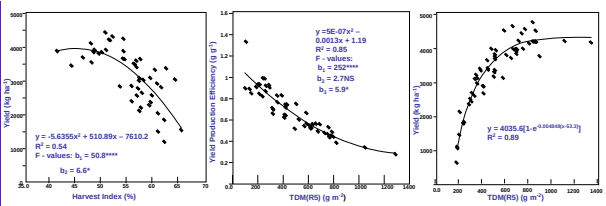

Fig. 1. Relationship between total dry matter at R5 [TDM(R5)], yield, yield production efficiency, and harvest index for soybean grown across a range of environmental and cultural conditions near Baton Rouge, LA, 1987-1996.
*, ***** Indicate statistical significance at the 0.05, and 0.0001 probability levels, respectively.
NS = not significant.

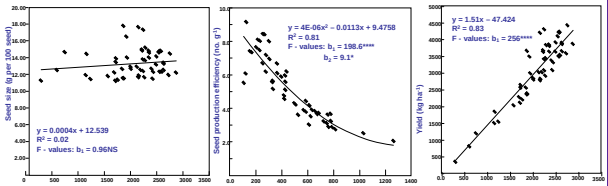

Fig. 2. Relationship between total dry matter at R5 [TDM(R5)], yield, seed size, seed number per area, and production efficiencies for yield and seed number for soybean grown across a range of environmental and cultural conditions near Baton Rouge, LA, 1987-1996.
*, **** Indicate statistical significance at the 0.05 and 0.0001 probability levels, respectively. NS= not significant.

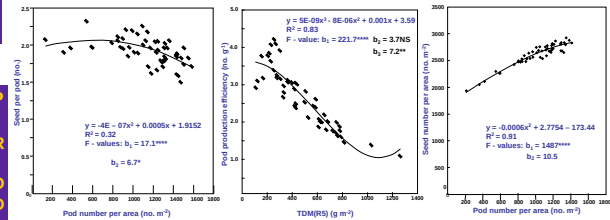

Fig. 3. Relationship between total dry matter at R5 [TDM(R5)], seed number per area, seed per pod, pod number per area, and pod production efficiency for soybean grown across a range of environmental and cultural conditions near Baton Rouge, LA, 1987-1996.
*, **, **** Indicate statistical significance at the 0.05, 0.01, and 0.0001 probability levels, respectively. NS=not significant

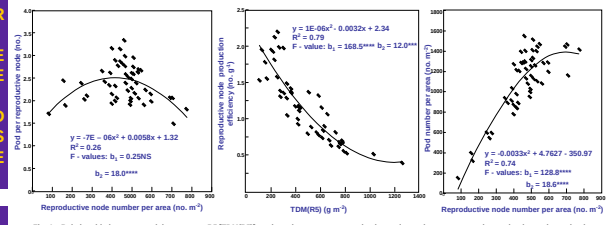

Fig. 4. Relationship between total dry matter at R5 [TDM(R5)], pod number per area, reproductive node number per area, and reproductive node production efficiency for soybean grown across a range of environmental and cultural conditions near Baton Rouge, LA, 1987-1996.
*, **** Indicate statistical significance at the 0.001 and 0.0001 probability levels, respectively. NS = not significant.

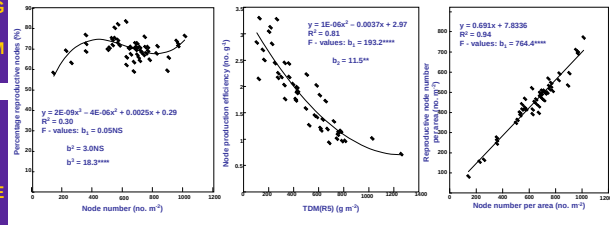

Fig. 5. Relationship between total dry matter at R5 [TDM(R5)], node number per area, reproductive node number per area, percentage reproductive nodes, and node production efficiency for soybean grown across a range of environmental and cultural conditions near Baton Rouge, LA, 1987-1996.
, ** Indicates statistical significance at the 0.01 and 0.0001 probability levels, respectively. NS= not significant.

RESULTS

YIELD FORMATION AT THE PRIMARY LEVEL.

- AS TDM(R5) INCREASED, YIELD PRODUCTION EFFICIENCY (g g^{-1}) DECREASED RESULTING IN A YIELD PLATEAU AT 600 g m^{-2}. THIS EXPLAINS THE INVERSE RELATIONSHIP OF HI AND YIELD (FIG.1).
- SINCE YIELD WAS CONTROLLED BY SEED NUMBER PER AREA AND SEED SIZE DID NOT COMPENSATE WITH IT, THE INVERSE RELATIONSHIP OF YIELD PRODUCTION EFFICIENCY WITH TDM(R5) WAS EXPLAINED BY THE INVERSE RELATIONSHIP OF SEED PRODCUTION EFFICIENCY WITH TDM(R5) (Fig. 2).

YIELD FORMATION AT THE SECONDARY LEVEL.

- SINCE SEED NUMBER PER AREA WAS CONTROLLED BY POD NUMBER PER AREA AND NO YIELD COMPENSATION OCCURRED BETWEEN SEED PER POD AND POD NUMBER PER AREA, THE INVERSE RELATIONSHIP OF SEED PRODUCTION EFFICIENCY WITH TDM(R5) WAS EXPLAINED BY THE INVERSE RELATIONSHIP OF POD PRODUCTION EFFICIENCY WITH TDM(R5) (Fig. 3).

YIELD FORMATION AT THE TERTIARY LEVEL.

- SINCE POD NUMBER PER AREA WAS CONTROLLED BY REPRODCUTIVE NODE NUMBER PER AREA AND NO COMPENSATION OCCURRED BETWEEN POD PER REPRODCUTIVE NODE AND REPRODCUTIVE NODE NUMBER PER AREA, THE INVERSE RELATIONSHIP OF POD PRODCUTION EFFICIENCY WITH TDM(R5) WAS EXPLAINED BY THE INVERSE RELATIONSHIP OF REPRODCUTIVE NODE PRODUCTION EFFICIENCY WITH TDM(R5) (Fig. 4).

YIELD FORMATION AT THE QUATERNARY LEVEL.

- SINCE REPRODCUTIVE NODE NUMBER PER AREA WAS CONTROLLED BY NODE NUMBER PER AREA AND NO COMPENSATION OCCURRED BETWEEN PERCENTAGE REPRODUCTIVE NODES AND NODE NUMBER PER AREA, THE INVERSE RELATIONSHIP OF REPRODUCTIVE NODE PRODCUTION EFFICIENCY WITH TDM (R5) WAS EXPLAINED BY THE INVERSE RELATIONSHIP OF NODE PRODCUTION EFFICIENCY WITH TDM(R5) (Fig. 5).

CONCLUSION

- THE INVERSE RELATIONSHIP BETWEEN HI AND YIELD RESULTS FROM AN INVERSE RELATIONSHIP BETWEEN TDM(R5) WITH NODE PRODUCTION EFFICIENCY (Fig. 5).