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COMPARISON OF THE NODAL DISTRIBUTION OF YIELD COMPONENTS OF INDETERMINATE SOYBEANS AT DIFFERENT PLANTING DATES

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ABSTRACT

Yield components on the nodes of soybean cultivars have different effects on yield. So, the nodal distribution of yield components is important. No report has yet been published on the effect of planting date on this vertical distribution in Iran. In field experiment conducted in 1983, nine indeterminate soybean cultivars were planted at four planting dates, with five replications. It was found that pod number, seed number, pod weight and 100-seed weight are distributed differently along the nodes and that most of these factors are located on the middle nodes, In medium maturing cultivars the above yield components are located mostly on the upper $^{2}/_{3}$ of the plant canopy and in early maturing cultivars on the lower $^{1}/_{3}$ of the canopy. Yield component expression of the cultivars at different planting dates varied. In general, early maturing cultivars produced maximum pod number, seed number and seed weight at the 27 May planting date, medium maturing Woodworth at the 24 April planting date and medium maturing Clark 63 at the 27 May planting date. Woodworth had the highest 100-seed weight at the 26 June planting date and Corsoy cultivar at the 27 May planting date. Woodworth and Williams (medium maturing) and Bonus and Steel (early maturing) produced the largest seeds. Woodworth was in all respects the highest among the cultivars.

1- Assistant Professors and former Graduate Student, respectively.

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مقایسه توزیع عمودی اجزاء عملکرد ارقام سویا در تاریخ‌های مختلف کاشت

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چکیده
اجزاء عملکرد در گره‌های مختلف ارقام سویا به میزان متفاوتی در افزایش عملکرد تاثیر دارند. از این رو بررسی وضعیت توزیع عمودی اجزاء عملکرد ارقام سویا از اهمیت ویژه‌ای برخوردار است. بخصوص اینکه در مورد اثر تاریخ‌های مختلف کاشت بر روی توزیع عمودی اجزاء عملکرد در ایران هنوز هیچ گزارشی منتشر نشده است.

در آزمایشهائی که در سالهای ۱۳۶۲ و ۱۳۶۳ انجام گرفت ۹ رقم سویای گل غیرانتهائی در ۴ تاریخ کاشت و در ۵ تکرار کشت گردید. در این آزمایشها مشخص گردید که تعداد غلاف، تعداد و وزن دانه، و وزن صد دانه سویا بطور متفاوتی در گره‌های مختلف توزیع شده‌اند و بیشترین مقدار هر یك از عوامل فوق در قسمتهای وسط کنوپی قرار دارد. بطور کلی ارقام متوسط رس حداکثر مقادیر متغیرهای فوق را در دوسوم بالای کنوپی و ارقام زودرس در نیمه پائینی کنوپی دارا می‌باشند.

اجزاء عملکرد ارقام سویا در تاریخ‌های کاشت متفاوت عکس‌العمل گوناگونی نشان دادند. بطور کلی حداکثر تعداد غلاف، تعداد و وزن دانه در ارقام زودرس کاشت ۶ خرداد، در رقم متوسط رس «وودورث» کاشت ۴ اردیبهشت، و در رقم متوسط رس «کلارك ۶۳» کاشت ۶ خرداد تولید شد. از نظر وزن صددانه، «رقم وودورث» در کاشت ۵ تیر و «کورسوی» در کاشت ۶ خرداد بالاترین مقدار را داشتند.

ارقام «وودورث» و «ویلیامز» (متوسط رس)، و«بونوس» و «استیل» (زودرس) درشت‌ترین دانه‌ها را تولید کردند. رقم «وودورث» از لحاظ تمام صفات مورد بررسی نسبت به سایر ارقام برتر بود.

INTRODUCTION

Nodal distribution patterns of grain yield components are useful in modeling soybean [(*Glycine max* (L.) Merrill)] growth, as factors responsible for yield differences, and in prediction of yield. Little research data are available on nodel distribution and effects of planting date on yield components in soybean.

Ramseur *et al.* (9) determined the influence of irrigation and intra-row spacing on the distribution of yield and yield components. They found that an increase in intra-row spacing increased the contribution of the lowest nodes to yield whereas irrigation decreased the relative contribution of the lowest nodal division.

Several studies with indeterminate soybeans have shown that most of the grain yield is located in the middle of the canopy (1,4,5,6). Weibold *et al.* (10) examined the yield distribution for 11 determinate cultivars grown in 0.97 m rows at 50.0 mm spacing. They found that at harvest, most pods were in the top one-third of the nodes of the canopy.

Hansen and Shibles (6) studied fruiting activities of "Hark" and "Hawkeye". They found that pod percent age at harvest time represented 37% of flowers produced in both cultivars. Great loss of reproductive structures occurred on branches and on lower main stem nodes. Flowering, podding and seed production were greatest in the lower middle portions of the plant nodes 6 to 15 on plants with 22 to 24 nodes per main stem.

Carlson *et al.* (3) conducted an experiment which included two soil moisture treatments and seven cultivars with differing maturity. The response of these soybeans varied considerably in their expression of seed yield and stress for individual components of yield, i.e., 100-seed weight, seed/pod, pods/node and node/plant varied over all cultivars.

The distribution of pods and seeds within a soybean canopy is influenced by genotype, plant spacing, irrigation and other environmental factors. The purpose of this experiment was to determine the influence of planting dates on the distribution of yield components in nine indeterminate soybean cultivars.

MATERIALS AND METHODS

This experiment was conducted at the experimental farm of the College of Agriculture, Isfahan University of Technology, in 1983 and 1984. The soil was a camborthid silty clay with a bulk density of 1.4 g cm^{-3}, a pH of 7.5, a field capacity of 22% and a permanent wilting point of 10% by weight. Average growing season (May–October) air temperature and precipitation in this area are 22.2° C and 16.4 mm., respectively.

The experiment was a complete randomized split plot design with planting dates (24 April, 27 May, 20 June and 11 July)[1] main plots and soybean cultivars (medium maturing cultivars[2] of Williams, Clark 63, A.R.F. Blackhawk) as subplots with five replicates. The seeds were hand planted on both sides of 0.9 m apart furrows with a density of 270000 plants per hectare. Each plot was 50 (5×10) square meters. Irrigation was done once a week. Before planting the seeds, 200 kg ha^{-1} of ammonium phosphate were incorporated into the soil.

Nodal distributions were determined by harvesting 10 randomly selected plants from each plot when more than 90% of the pods turned brown. Number of nodes/plant, pods/node, seeds/pod, branches and weight of seeds were then determined.

1- These dates are 4th of Ordibehesht, 6th of Khordad and 5th and 20th of Tir, respectivey using the Persian calendar.

2- This grouping of cultivars is valid only in the Isfahan area with about 32° latitude

RESULTS AND DISCUSSION

a) Planting Date

Table 1 shows branch number and yield components means at three planting dates. It is seen that the effect of planting date on the number of branches is not significant, but number of nodes, number of pods, number of seeds, seed weight, and 100-seed weight were affected. Yield components for the 11 July planting date were not entered into the analysis because the early cold weather in autumn did not allow maturation of these cultivars.

Table 1 shows that the 27 May planting date produced more pods and seeds and a higher seed weight than the other planting dates. The late planting (26 June) causes the plants to flower very soon and to be short in stature. This reduces grain yields. Also, the 24 April early planting causes seed filling period to be simultaneous with the hot days of summer, and hence, the seed yield is reduced. In addition, the 27 May planting had adequate time from emergence to flowering to express stature and nodes. This also caused the seed filling period to coincide with cool days of late summer.

Table 2 shows results of branch number and yield components averaged over planting dates for the nine soybean cultivars. Generally, pod number, seed number and seed weight for Woodworth were highest and for Steel was the lowest. The reason for the low number of pods and seeds, and less seed weight in Steel is that it flowers early, thus, it mature sooner than Woodworth.

As a whole, yield components of the medium maturing cultivars (Woodworth, Clark 63, Williams and S.R.F. 450) are greater than the other early maturing cultivars.

Table 1. Means of branch number and yield components of different soybean cultivars at different planting dates (each value is the average of nine cultivars).

Planting date†	Node No.	Branch No.	Pod No.		Seed No.		Seed wt.(g)		100-seed wt. (g)
			whole	stem	whole	stem	whole	stem	whole
24 April	19 a§	2.6 a	37.4 b	29.3 b	82.4 b	64.9 b	11.3 b	9.1 b	13.7 b
27 May	20 a	2.5 a	44.8 a	34.0 a	101.2 a	75.7 a	16.7 a	12.6 a	16.5 a
26 June	17 b	2.6 a	34.4 c	25.1 c	80.2 b	58.4 c	12.2 b	9.6 b	15.2 a

† *Planting date of 11 July is not entered in the analysis because the plants did not mature.*

§ *Means within each column followed by the same letter are not significantly different at 1% probability level by Duncan multiple range test.*

Table 2. Means of branch number and yield components of nine cultivars (each value is average of three planting dates).

Cultivar	Node	Branch	Pod No		Seed No.		Seed wt.(g)		100-seed wt. (g)
	No.	No.	whole	stem	whole	stem	whole	stem	whole
Blackhack	20 b†	2.1 d	37.7 cd	29.7 d	75.2 d	59.5 d	10.6 e	8.5 c	14.1 c
Bonus	20 b	2.7 bc	36.1 d	26.1 ef	78.7 d	55.3 e	12.0 d	8.6 c	15.2 b
Clark 63	22 a	2.3 cd	36.6. d	32.0 c	108.b	90.6 a	16.2 b	14.3 a	14.9 bc
Corsoy	19 b	3.5 a	36.3 d	22.3 g	77.0 d	48.5 f	11.2 de	7.6 d	14.5 c
Hark	19 b	1.6 c	32.2 e	24.8 f	64.5 e	50.3 f	9.6 f	7.5 d	14.9 bc
S.R.F. 540	22 a	2.8 b	48.6 b	30.9 cd	107.6 b	79.9 c	15.2 c	11.7 b	14.1 c
Steel	19 b	2.1 d	38.4 de	27.1 e	58.1 f	45.0 g	8.3 g	6.4 c	14.3 c
Williams	22 a	2.4 bcd	40.6 be	35.3 b	88.2 c	85.6 b	16.7 b	14.6 a	17.0 a
Woodworth	22 a	3.5 a	51.0 a	37.9 a	122.8 a	92.7 a	19.4 a	14.8 a	15.8 b

† *Means within each column followed by the same letter are not significantly different at the 1% probability level by Duncan multiple range test.*

b) Nodal Distribution of Yield Components

With respect to seed size, Woodworth and Clark 63 (medium maturing group) and Bonus and Corsoy (early maturing group) had the largest seeds. Therefore, the following figures are shown only for these four cultivars.

In each cultivar, yield componenets are distributed differently on the nodes as also shown by others (1,3). Generally, it was found here that the yield components of medium maturing cultivars are mostly located on the upper $^{2}/_{3}$ of the canopy with the early maturing cultivars yield components on the lower $^{1}/_{3}$ of the canopy. This difference was probably due to solar radiation interception and leaf area distribution within the canopy.

Fig. 1 shows the nodal distribution of pod number for four soybean cultivars and four planting dates. At the 24 April planting date, Woodworth and Clark 63 had the largest pod number, especially on the middle nodes. The 27 May planting date Clark 63 produced more pods on the middle and upper nodes than for other cultivars. But, on lower nodes, Corsoy had more pods, This may be related to deeper light penetration into the canopy. At the 26 June planting date, Woodworth had more pods than the other cultivars only from the 10th node to the upper nodes. For the 11 July planting date, Woodworth and Clark 63 were not harvested, because they never matured, and the difference between Bonus and Corsoy was not significant. As a whole, the 27 May planting date produced more pods. Fig. 2 shows the nodal distribution for seed number at different planting dates as shown in Fig. 3. At the 24 April planting date, Bonus had larger seeds than the rest of the cultivars except on the upper nodes. At the 27 May planting date, Bonus and Woodworth had larger seeds. At the 26 June planting date, Woodworth and Bonus had larger seeds on almost all nodes. Only Bonus and Corsoy produced harvestable seeds for the 11 July planting date with seeds larger than Corsoy. In general, the 11 July planting date produced smaller seeds because there was not enough time for seed fill.

Fig. 4 shows the nodal distribution of seed weight for different

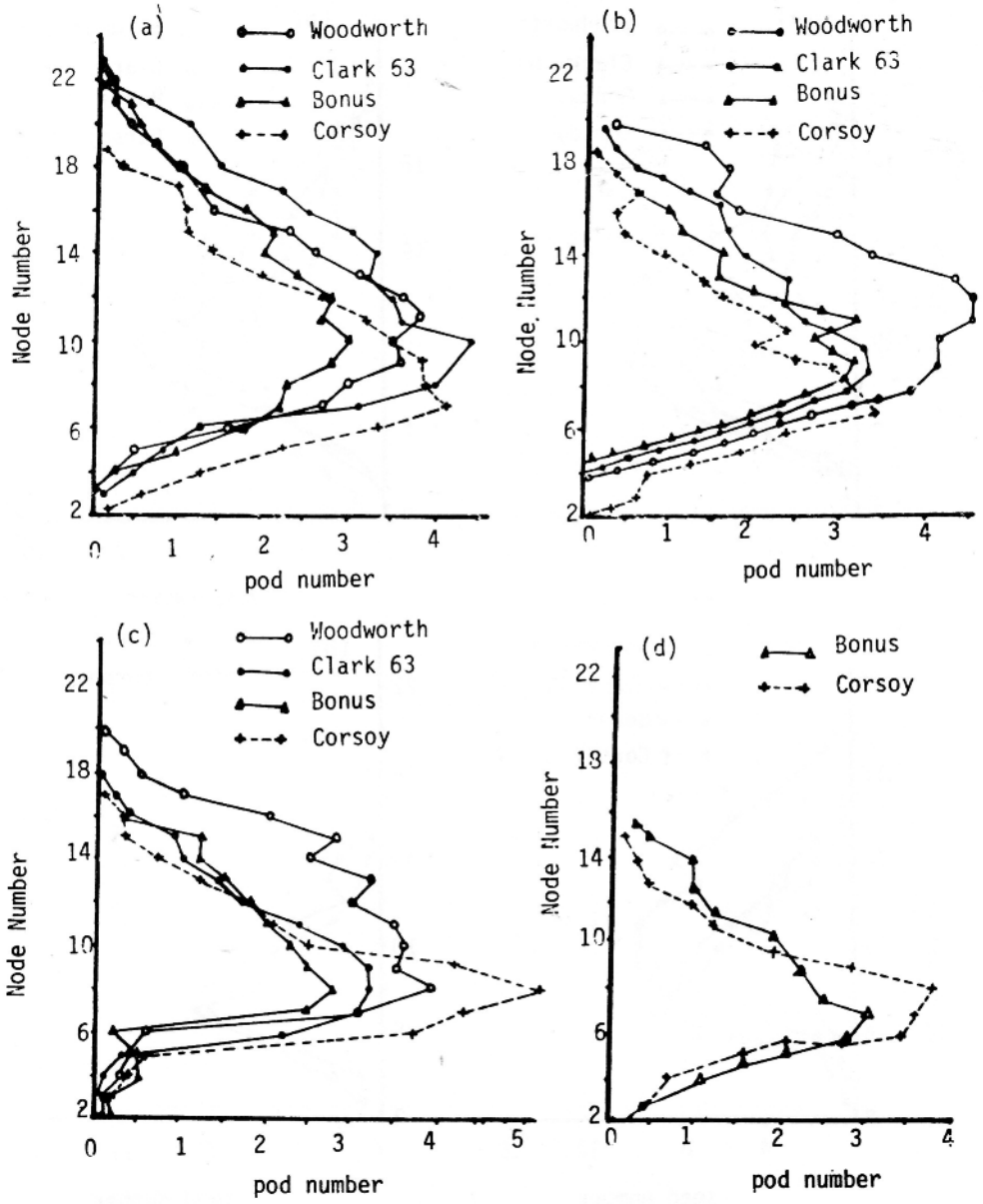

Fig. 1. Pod number of soybean cultivars at planting dates of:
a) 24 April *b)* 26 June *c)* 11 July.

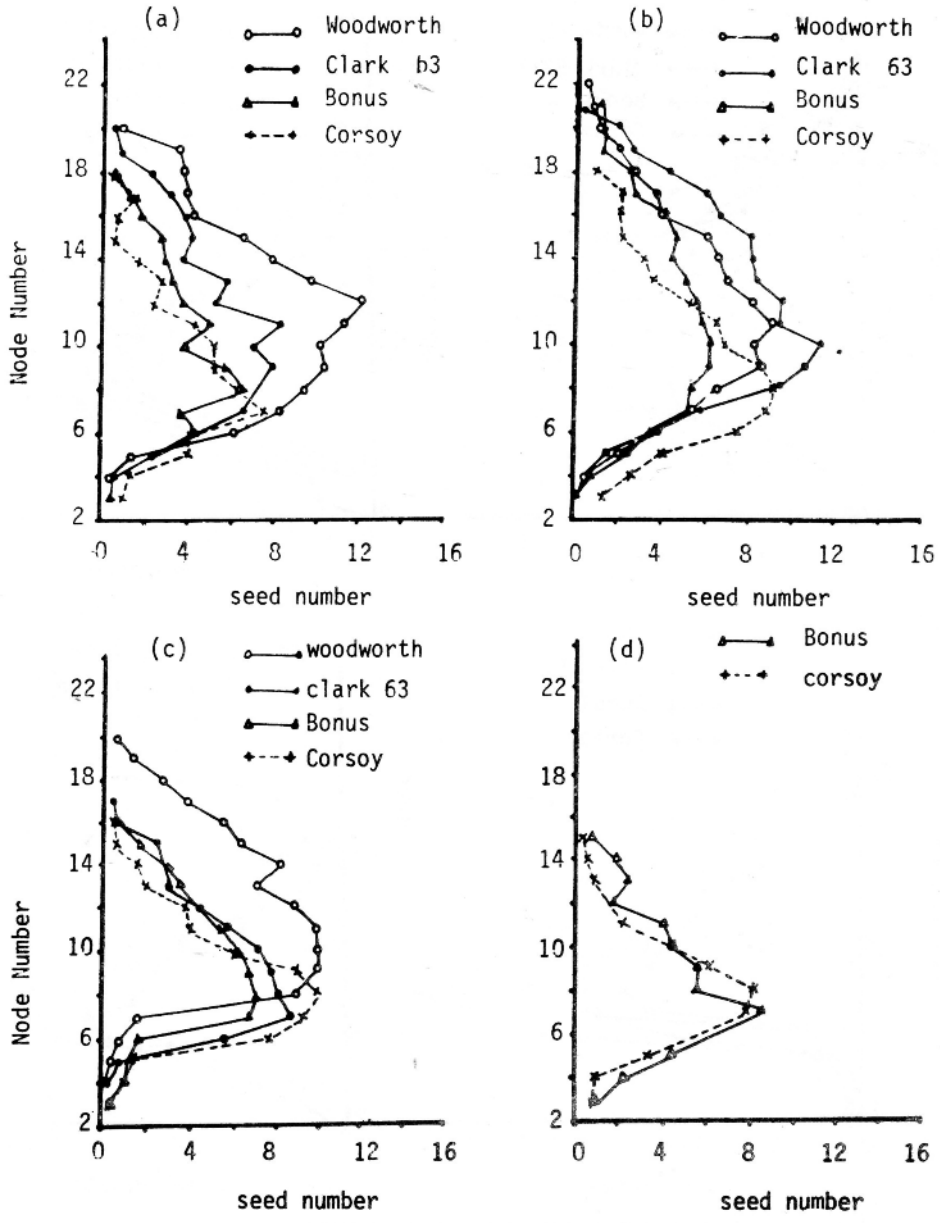

Fig. 2. Seed number of soybean cultivars at planting dates of:
a) 24 April *b)* 24 May *c)* June *d)* 11 july.

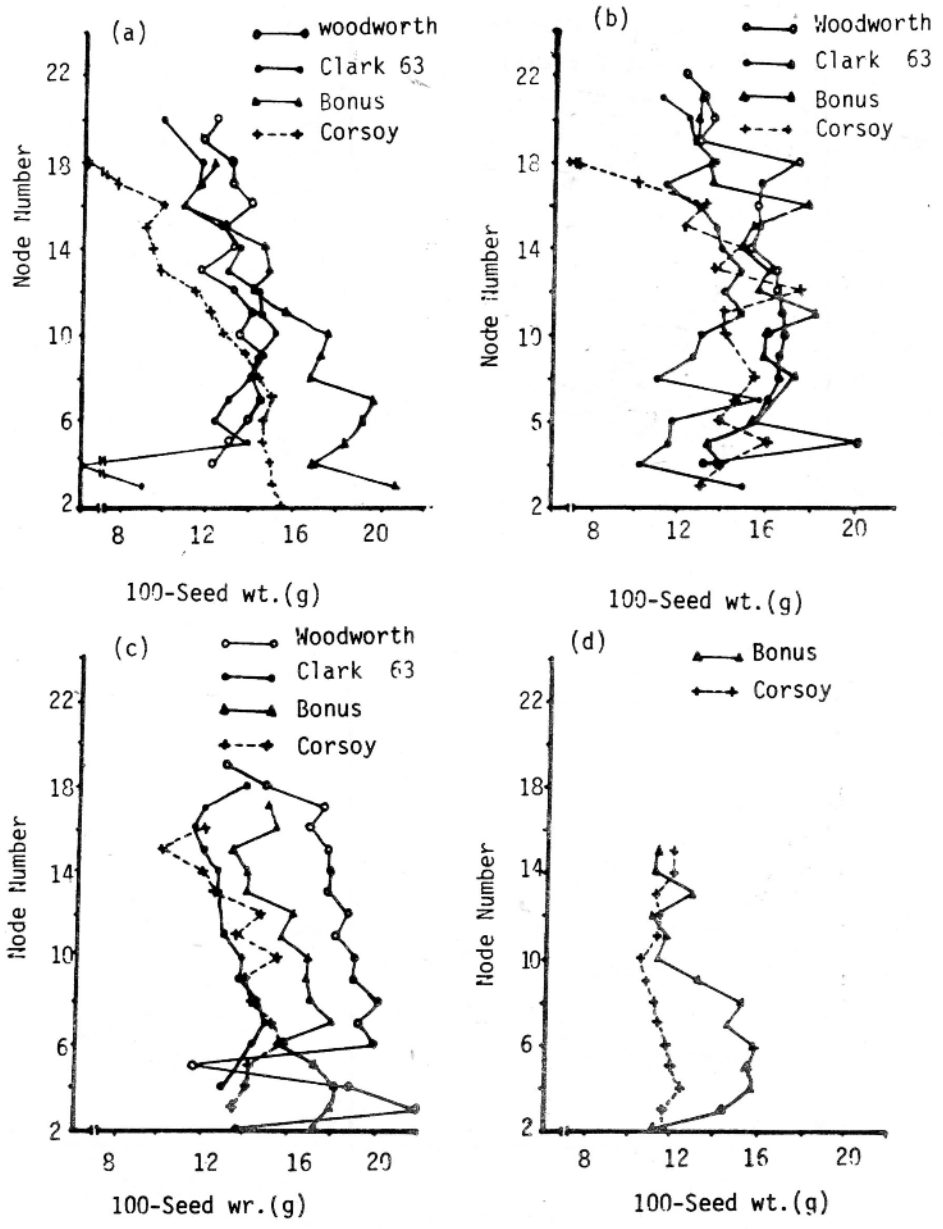

Fig. 3. 100-Seed weight of soybean cultivars at planting dates of:
a) 24 April *b)* 27 May *c)* 26 June *d)* 11 July.

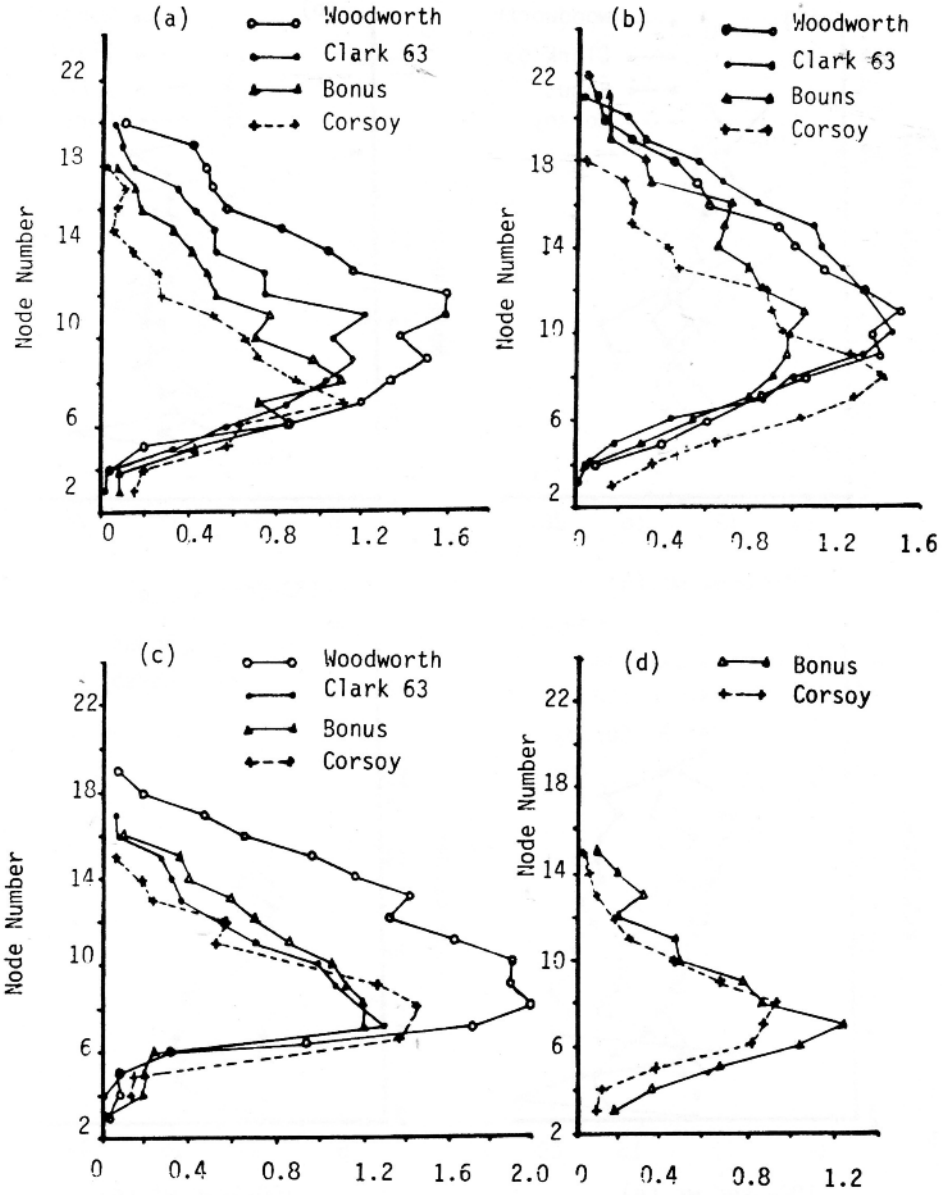

Fig. 4. Seed weighgt of soybean cultivars at planting dates of:
a) 24 April *b)* 27 May *c)* 25 June *d)* 11 July.

planting dates. The behavior is very similar to Fig. 1. The correlation coefficients (r) between branch number, seed number and 100-seed weight and grain yield were 0.53, 0.50 and 0.59, respectively.

LITERATURE CITED

1. Anderson, L.R. and B.L. Vasilas. 1985. Effects of planting date on two soybean cultivars: seasonal dry matter accumulation and seed yield. Crop Sci. 25:999-1004.
2. Board J.E. 1985. Yield components associated with soybean yield reductions at nonoptimal planting dates. Agron. J. 77 : 135-140.
3. Carlson, R.E., M. Karimi-Abadchi, and R.H. Shaw. 1982. Comparison of the nodal distribution of yield components of indeterminate soybeans under irrigated and rain-fed conditions. Agron. J. 74: 531-533.
4. Domingues, C. and D.J. Hume. 1978. Flowering, abortion, and yield of early maturing soybeans at three densities. Agron. J. 70:801-805.
5. Fehr, W.R. and C.E. Caviness. 1977. Stages of soybean development, Iowa Agric. Home Econ. Exp. Stn., Iowa Coop. Ext. Serv Rep. 80.
6. Hansen, W.R., Shibles. 1978. Seasonal log of the flowering and podding activity of field-grown soybeans. Agron. J. 70:47-50.
7. Johnston, T.J., and J.W. Pendleton. 1968. Contribution of leaves at different canopy levels to seed production of upright and lodged soybeans. Crop Sci. 8:291-293.
8- Koller, H.R. 1971. Analysis of growth within distinct strata of the soybean community. Crop Sci. 11:400-402.
9- Ramseur, E.L., S.U. Wallace and V.L. Quisenberry. 1984. Distribution pattern of yield components in Braxton soybeans. Agron. J. 76:439-497.
10- Weibold, W.J., D.A. Ashey and H.R. Boerma. 1981. Reproductive abscission levels and pattern for eleven determinate soybean cultivars. Agron. J. 73:43-46.