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Emergence and Seedling Vigor of Annual Trifolium Species

E. C. Holt and P. A. Rich[1]

SUMMARY

Temperate annual legume species differ in ability to emerge from deep planting, and the differences are not limited to seed size differences. Subterranean and berseem clovers emerged better from deep (40 mm) than from shallow (10 mm) planting, both with large seed, while persian, with the smallest seed, showed little difference between the two depths. Deeper planting generally tends to reduce total emergence. Deeper planting may favor initial nodulation (3) because of less moisture and temperature stress, and most species will emerge from deeper depths than usually suggested for planting. However, seedling size also is generally reduced by deeper planting, even if emergence is not affected. Surprisingly, plant height near maturity may reflect the effect of deep planting on early development of the seedling.

Seedling vigor (weight) varied three fold among species and up to two fold within species. While this relationship seemed to be accounted for in part by seed size, there was enough variation within similar seed sizes to suggest additional seedling vigor factors or causes.

The relationship between seed size and seedling vigor is much stronger than that between seed size and emergence percentage. This relationship holds both across species and generally among genotypes within species. Subterranean clover, with the largest seed, showed the least consistent relationship.

While none of the experimental materials in this study exceeded the commercial variety check in seedling vigor, the study indicates differences in seedling vigor and therefore the potential for improving seedling vigor.

Introduction

Temperate annual legumes, primarily Trifolium species, are increasing in use because of their potential for extending the grazing season, fixing nitrogen and improving forage quality. Because these legumes are usually seeded with a companion crop and/or overseeded on sod, the seedlings are subjected to varying degrees of competition during the establishment stage. Furthermore, the seedlings usually develop slowly resulting in little dry matter production until late winter. Two major needs in the annual legumes are the ability to emerge under less than ideal conditions and seedling vigor to improve establishment and early growth under less than ideal conditions, and

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[1] Professor and research associate, respectively, Soil & Crop Sciences Department, College Station, Texas 77843.

seedling vigor to improve establishment and early growth under competition.

Rich, Holt and Weaver (3) have shown that depth of planting is an important factor in rhizobia survival and nodulation of Yuchi arrowleaf clover. Further, nodulation is favored by deeper seed placement than is emergence. Other studies (1, 2, 4, 5) have implicated seed size as an important factor in emergence from deeper planting depths.

Seed size varies with the annual Trifolium species and even more widely among species. A field test was conducted to evaluate emergence and seedling vigor in several Trifolium species.

Experimental Procedure

Annual Trifolium clover species included in this study are arrowleaf (T. vesiculosum Savi), subterranean (T. subterraneum L.), persian (T. resupinatum L.), berseem (T. alexandrium L.), and rose (T. hirtum All.). One or more named varieties and two to four plant introductions within each species were included. The experimental materials are listed in Table 1.

Seed weight and viability were determined for each seed lot (Table 1). Seeding rate was constant but the number of viable seed per unit length of row was calculated and percentage emergence was based on the number of viable seed planted.

Each of the 25 seed sources was planted at two depths, 10 and 40 mm. The seed source-depth combinations were completely randomized within each of 4 replications. Individual plots consisted of a single row 2.13 m long, rows spaced 1 m. Planting was on November 12, 1980.

Plant counts and seedling weights were determined on January 12, 1981. Plants from a 60 cm section of row were removed at the soil surface, counted, dried, weighed and individual seedling weights calculated. plant height was measured on April 2, 1981.

Results and Discussion

Species Responses and Differences

Seed size ranged from 714 mg/100 seed to 60 mg/100 seed. Average seed weights by species in mg/100 seed were: subterranean, 572; rose, 280; berseem, 248; arrowleaf, 118; and persian, 79. A two fold difference in seed size occurred among sources within both arrowleaf and rose clovers.

Average values for the five species for emergence, seedling weight and seedling height at the two planting depths are shown in Table 2. Berseem showed the best average emergence and subterranean the poorest though the differences were not significantly different. Both berseem and subterranean emerged better from 4 cm than from 1 cm planting depth. The other three species emerged better from 1 cm depth, with arrowleaf showing the most depression with deeper

planting. Emergence response to deep planting was not very closely related to seed size. Subterranean which had the largest seed showed the greatest increase (80%) in emergence with deep planting. However, berseem and rose which had somewhat similar size seeds showed different responses to deep planting, berseem increasing in emergence with deep planting (35%), and rose decreasing (-15%). Similarly, persian which had the smallest seed decreased less with deep planting (-9%) than arrowleaf (-28%) which had 50% larger seed than Persian.

Seedling vigor (above ground seedling weight) differed significantly among species and also with planting depth. Subterranean, berseem and rose had heavier seedlings than persian and arrowleaf clovers. Seedling vigor (weight) at 60 days post planting was related to seed weight. Deep planting (40 mm) reduced seedling weight approximately 12%. Species differed in plant height near maturity largely because of differences in plant growth habit. Subterranean clover, because of its prostrate growth habit, was the shortest type with berseem being significantly taller than the other species. The slightly slower initial development from deep planting was still reflected in plant height in early April, plants from 40 mm planting depth being 10% shorter on the average than from shallow planting. Berseem and subterranean were exceptions to this pattern.

The species data indicate that arrowleaf clover emergence is affected negatively by increasing planting depth more than is the emergence of the other species and that subterranean and berseem may be favored by deeper planting. Rich, Holt and Weaver (3) found that maximum emergence of Yuchi arrowleaf occurred with 10 mm planting depth but with no significant difference over a range of 10 to 25 mm. Seed size had a greater impact on seedling vigor than on emergence, even emergence from 40 mm planting depth. When seedling weights of all 25 seed sources and two planting depths are ploted against seed weights, the relationship was linear and significant (Figure 1). As seed weight increased, seedling weight at 60 days post planting increased. The spread among similar seed weights increased above 200 mg/100 seed.

Within Species Responses

Arrowleaf - Percentage emergence (Table 3) based on viable seed varied widely but was not related to percent viability nor to seed size (Figure 2A). Differences in emergence at the two depths appeared to be as great for heavier seed as for lighter seed. The only accession showing increased emergence with deeper planting was the poorest emerging accession and its seed weight was intrmediate. Seedling vigor varied markedly among the seven sources indicating considerable potential for improving these characteristics. However none of the plant introductions equaled the best available varieties for seedling vigor. Seedling vigor was related to seed size (Figure 2B). The loss in vigor due to deeper planting was as great with heavier seed as with lighter seed. Plant height varied about two fold primarily because of one short type among the accessions.

Subterranean - Seed viability was relatively low in all the subclover sources and especially in two of the sources, but was not a factor in emergence from viable seed. The range in emergence (Table

4) was about three fold with generally better emergence from deeper plantings. While the relationship between seed size and emergence was not close, there appeared to be a tendency for larger seed to result in less emergence (Figure 2C). On the other hand seed size showed a general though not close relationship to seedling vigor. Planting depth had no influence on either seedling vigor or plant height.

Persian - Though average percentage emergence ranged among sources from 36 to 62%, the differences were not significant statistically (Table 5). Some of the sources emerged better from 10 mm and some better from 40 mm. Emergence from deep planting was influenced by seed size (Figure 2E) but not emergence from shallow planting. Sources did not differ in seedling vigor (Table 5) and none of the plant introductions exceeded Abon in actual plant weight. Deep planting consistently reduced seedling weight at 60 days post planting but the difference was not significant statistically. Seed weight seemed to have a positive influence on seedling vigor (Figure 2F).

Berseem - Seed of only two plant introductions was available (Table 6). Emergence was better at 40 mm with all three sources and the sources differed significantly. Similarly, sources differed in seedling vigor and as a result of planting depth. The Winter Hardy selection was superior in seedling vigor to the two plant introductions.

Rose - Seed viability varied widely but did not seem to be a factor in emergence percentage of viable seed. Average emergence ranged from 14% to 62% with some sources emerging better from 10 mm and others from 40 mm planting depths (Table 7). Seedling vigor differed among sources and was significantly reduced by deeper planting. Even those sources that emerged better from deeper planting showed a negative effct of planting depth on seedling vigor. Both seedling emergence (Figure 2G) and seedling vigor (Figure 2H) showed a general positive relationship to seed weight.

Literature Cited

1. Beveridge, J. L., and C. P. Wilsie. 1959. The influence of depth of planting, seed size, and variety on seedling vigor in alfalfa. Agro. J. 51:731-734.

2. Black, J. N. 1956. The influence of seed size and depth of sowing on emergence and early growth of subterranean clover. Aust. J. Agric. Res. 7:98-109.

3. Rich, P. A., E. C. Holt, and R. W. Weaver. 1982. Establishment and nodulation of arrowleaf clover (Trifolium vesiculosum Savi). Agro. J. (Submitted).

4. Townsend, C. E. 1972. Influence of seed size and depth of planting on seedling emergence of two milkvetch species. Agro. J. 64:627-630.

5. Townsend, C. E. 1979. Associations among seed weight, seedling emergence and planting depth in Cicer milkvetch. Agro. J. 71:410-414.

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Table 1. Seed Characteristics of Trifolium accessions.

Entry no.	Trifolium species	Variety or P.I.	Seed wt. mg/100 seed	% germination
1	T. vesiculosum	Yuchi	138	70.0
17	"	Meechee	147	22.5
18	"	Amclo	126	40.5
2	"	233782	110	15.0
3	"	233816	121	42.5
4	"	279948	69	70.0
5	"	234310	114	55.0
6	T. subterraneum	Mt.Barker	714	11.0
7	"	190568	648	38.5
8	"	233866	496	37.5
9	"	277439	570	32.5
10	"	287998	442	18.0
11	T. resupinatum	Abon	97	79.0
12	"	120195	60	37.0
13	"	141503	87	61.0
14	"	173974	82	60.5
15	"	204937	67	56.0
16	T. alexandrium	Winter Hardy Exp.	273	75.0
19	"	251213	204	56.5
20	"	292967	268	35.5
21	T. hirtum	Kondinin	328	52.0
22	"	BN9873-58	286	24.0
23	"	311485	318	88.0
24	"	287974	167	73.0
25	"	348886	300	25.5

Table 2. The influence of species and planting depth on emergence, and seedling vigor of temperate legumes, College Station, 1980-81.

Species	Planting depth (mm) 10	40	Average
	% emergence, January 15		
Berseem	40	54	47.0
Persian	47	43	45.0
Rose	47	40	43.5
Arrowleaf	47	34	40.5
Subterranean	25	45	35.0
Average	47	34	
	Weight/seedling (mg), Janurary 15		
Subterranean	20.2	20.5	20.3a
Berseem	18.4	16.2	17.3a
Rose	17.1	14.1	15.6a
Arrowleaf	8.3	6.5	7.4b
Persian	7.8	6.3	7.1b
Average	13.6a	12.0b	
	Seedling height (cm), April 2		
Berseem	31	32	31.5a
Persian	24	20	22.0b
Rose	22	20	21.0b
Arrowleaf	21	19	20.0b
Subterranean	8	8	8.0c
Average	21.2a	19.2b	

Table 3. The influence of planting depth on emergence and seedling vigor of arrowleaf clover sources, College Station, 1980-81.

Entry no.	Variety or P.I.	Planting depth (mm) 10	40	Average
		% emergence		
3	233816	66.2	39.0	52.6a
2	233782	56.3	34.0	45.1ab
18	Amclo	52.3	34.5	43.1abc
4	279948	50.3	32.3	41.3abc
1	Yuchi	41.5	39.5	40.5abc
17	Meechee	46.5	33.0	39.8abc
5	234310	14.8	23.5	19.1c
Average		46.8a	33.7b	
		Weight/seedling (mg)		
17	Meechee	11.0	7.6	9.3a
1	Yuchi	9.6	7.5	8.6ab
18	Amclo	8.9	7.5	8.2ab
3	233816	7.6	7.6	7.6b
2	233782	8.8	6.0	7.4b
5	234310	8.6	5.9	7.2b
4	279948	3.8	3.4	3.6c
Average		8.3a	6.5b	
		Seedling height (cm)		
1	Yuchi	29.2	23.5	26.4a
18	Amclo	26.5	23.0	24.8ab
3	233816	22.0	19.0	20.5b
2	233782	21.2	17.8	19.5bc
5	234310	17.5	21.0	19.3c
17	Meechee	20.2	17.5	18.9c
4	279948	12.8	11.0	11.9d
Average		21.4a	19.0b	

Table 4. The influence of planting depth on emergence and seedling vigor of subterranean clover sources, College Station, 1980-81.

Entry no.	Variety or P.I.	Planting depth 10	40	Average
		% emergence		
9	277439	42.8	78.3	60.5a
8	233866	23.0	39.3	31.1ab
10	287998	34.0	28.0	31.0ab
6	Mt. Barker	8.5	27.0	29.3ab
7	190568	16.0	27.0	21.5b
Average		24.9b	44.5a	
		Weight/seedling (mg)		
9	277439	27.9	31.4	29.7a
6	Mt. Barker	24.6	21.4	23.0ab
7	190568	20.9	24.6	22.8ab
8	233866	23.3	16.0	19.7ab
10	287998	16.6	18.3	17.5ab
Average		22.7a	22.3a	
		Seedling height (cm)		
6	Mt. Barker	-	-	-
7	190568	8.5	10.2	9.4
9	277439	9.8	8.2	9.0
8	233866	5.0	6.5	5.8
10	287998	-	7.5	-
Average		7.8	8.1	

Table 5. The influence of planting depth on emergence and seedling vigor of Persian clover sources, College Station, 1980-81.

Entry no.	Variety or P.I.	Planting depth (mm) 10	40	Average
		% emergence		
11	Abon	58.5	66.3	62.4a
12	120195	45.5	48.5	47.0a
14	173974	50.8	32.0	41.4a
13	141503	37.8	42.0	39.9a
15	204937	46.5	26.3	36.4a
Average		47.4a	43.0a	
		Weight/seedling (mg)		
11	Abon	9.8	8.1	8.9a
14	173974	9.2	7.5	8.4a
13	141503	8.1	5.8	6.9a
12	120195	6.2	5.1	5.6a
15	204937	5.7	5.3	5.5a
Average		7.8a	6.4a	
		Seedling height (cm)		
12	120195	28.0	19.8	23.9a
14	173974	23.8	24.0	23.9a
11	Abon	24.8	20.8	22.8a
13	141503	24.0	20.5	22.2a
15	204937	21.5	13.8	17.6a
Average		24.4a	19.8a	

Table 6. The influence of planting depth on emergence and seedling vigor of berseem sources, College Station, 1980-81.

Entry no.	Variety or P.I.	Planting depth (mm) 10	40	Average
		% emergence		
16	Winter Hardy Exp.	52.0	61.8	56.9a
19	251213	50.0	60.5	55.3a
20	292967	17.5	40.3	28.9b
Average		39.8b	54.2a	
		Weight/seedling (mg)		
16	Winter Hardy Exp.	24.0	19.0	21.5a
19	251213	16.6	17.6	17.1b
20	292967	14.6	12.1	13.4c
Average		18.4a	16.2b	
		Seedling/height (cm)		
16	Winter Hardy Exp.	30.0	34.2	32.1
19	251213	31.8	30.2	31.0
20	292967	-	23.0	-
Average		30.9	32.2[1]	

[1]Value does not include entry 20.

Table 7. The influence of planting depth on emergence and seedling vigor or rose clover sources, College Station, 1980-81.

Entry no.	Variety or P.I.	Planting depth (mm) 10	40	Average
		% emergence		
21	Kondinin	75.0	49.5	62.3a
22	BN9873-58	65.0	53.8	59.4a
23	311485	50.3	58.0	54.1a
25	348886	34.0	22.0	28.0b
24	287974	10.0	18.0	14.0b
Average		46.9a	40.3a	
		Weight/seedling (mg)		
21	Kondinin	21.9	17.2	19.5a
25	348886	17.4	19.1	18.2ab
23	311485	20.8	14.6	17.7ab
22	BN9873-58	13.5	12.0	12.8bc
24	287974	12.2	8.0	10.1c
Average		17.2a	14.2b	
		Seedling/height (cm)		
21	Kondinin	29.2	24.2	26.8a
23	311485	27.5	23.5	25.5a
22	BN9873-58	20.2	18.5	19.4b
24	287974	19.0	17.8	18.4b
25	348886	14.8	17.0	15.9b
Average		22.2a	20.2a	

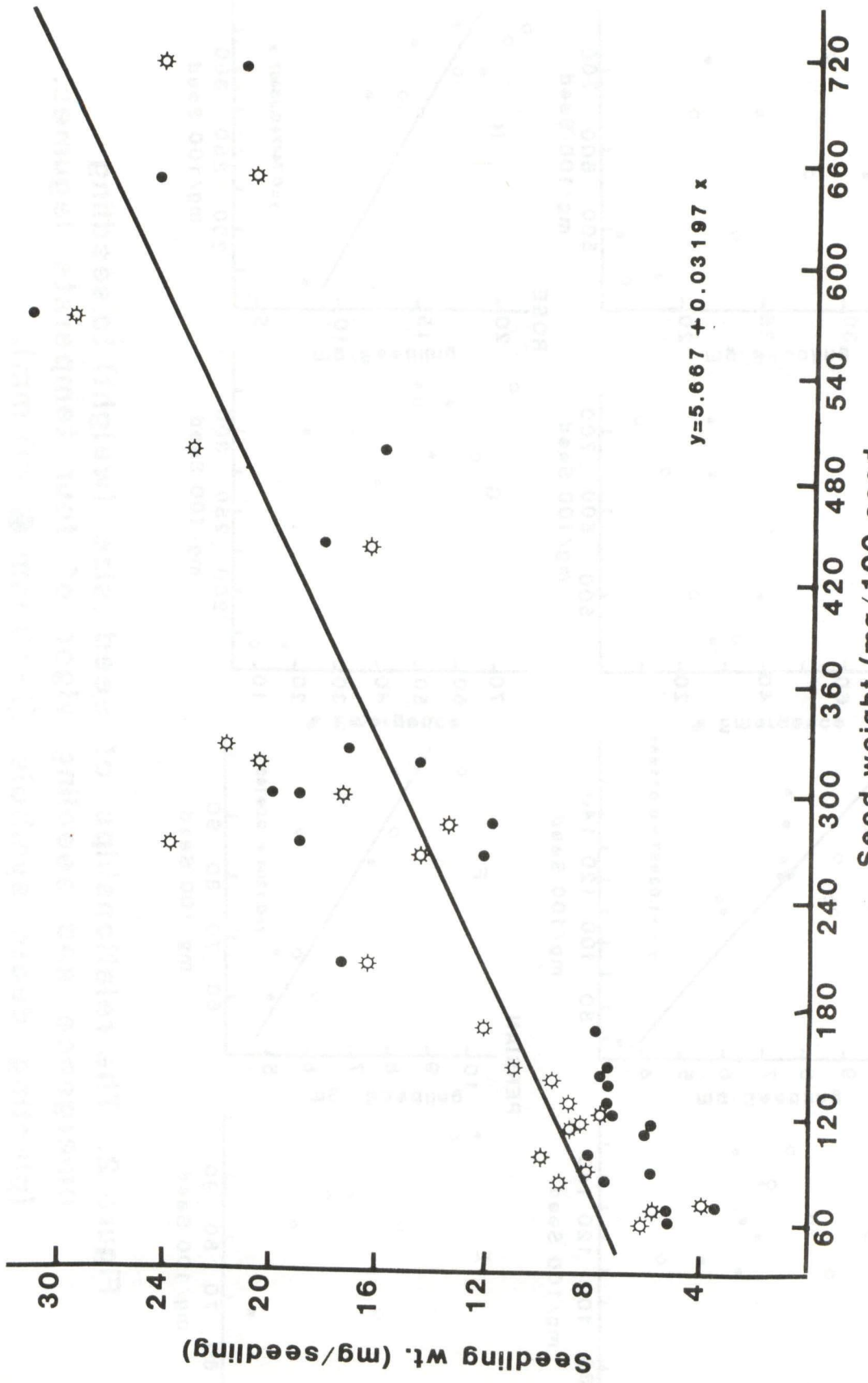

Figure 1. The relationship of seed size (weight) to seedling vigor (weight of tops) of temperate legumes (planting depth symbols: ☼ -10 mm, ● -40 mm).

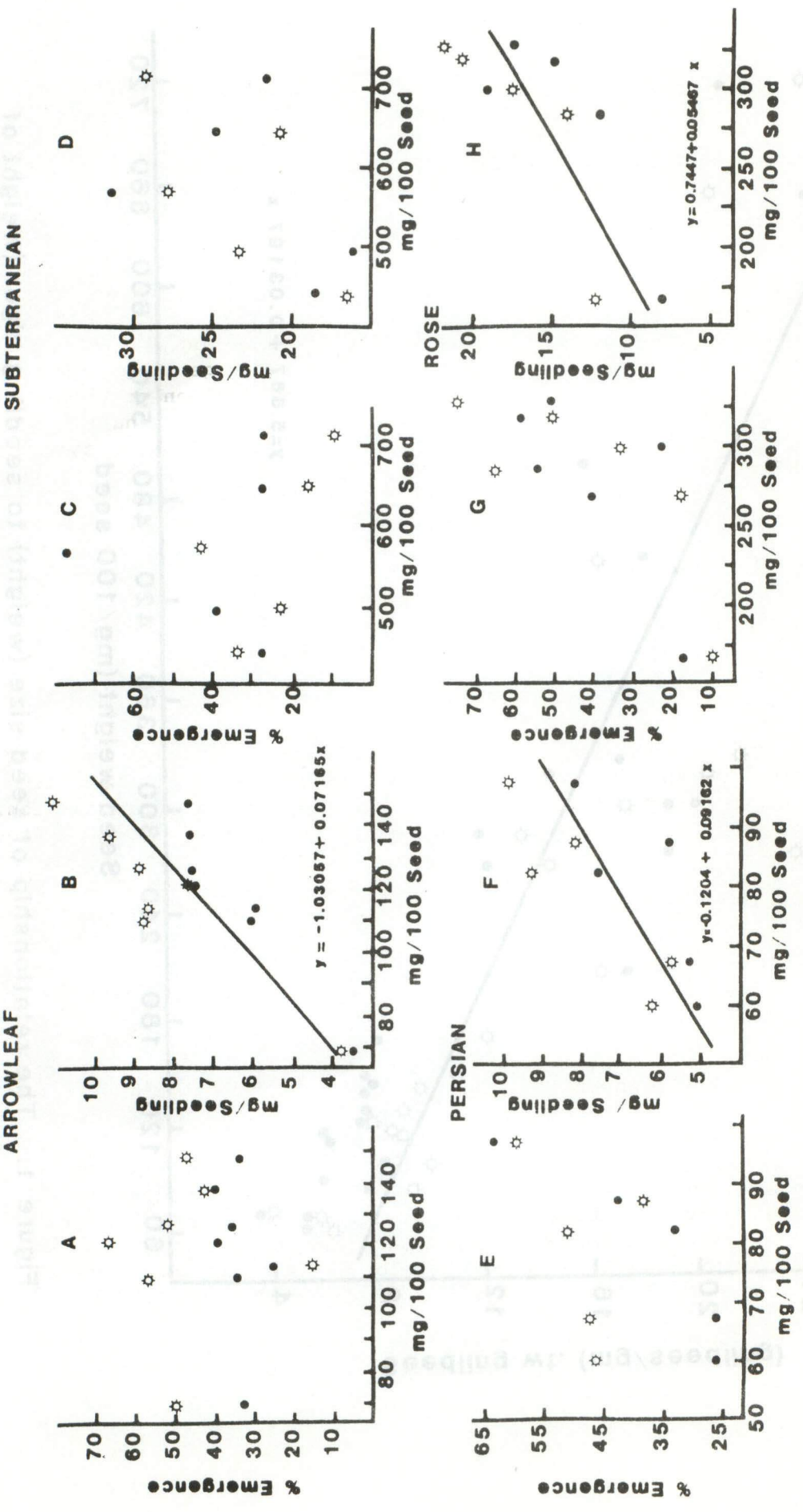

Figure 2. The relationships of seed size (weight) to seedling emergence and seedling vigor of four temperate legumes. (planting depth symbols : ☼-10 mm, ●-40 mm).