QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 408

SOWING RATE, SURVIVAL AND PRODUCTIVITY OF GREEN PANIC-GLYCINE MIXTURES

By P. G. Tow, B.Sc.

SUMMARY

Green panic (*Panicum maximum* var. *trichoglume*) and glycine (*Glycine javanica* cv. Tinaroo) populations declined over a 2-year period, especially following high seeding rates. Losses were severe only in the legume, which was particularly sensitive to heavy seeding rates of grass. After deferment of defoliation for 5½ months in the second year, the legume cover was satisfactory only where its population density exceeded one plant per 10 sq. lk.

High yields almost entirely made up of green panic were recorded. It is argued that maximum production could have been obtained from green panic alone without glycine complicating the management.

I. INTRODUCTION

On the Kairi Research Station on the Atherton Tableland in northern Queensland, the legume *Glycine javanica* cv. Tinaroo has exhibited outstanding productivity under grazing. Successful establishment has been obtained with normal mechanical weed control and lenient grazing in the first year, and in mixture with *Panicum maximum* var. *trichoglume* (green panic) it has persisted well under grazing for up to 12 years.

On parts of the Atherton Tableland, however, failure of sowings or lack of persistence of glycine is common. Tow (1960) observed that vigorous weed growth was accompanied by thinning out of legume seedlings and that glycine was successfully established in old grassland only where the grass lacked vigour or was markedly set back by cultivation. However, in clean-cultivated rows in the plant introduction nursery, glycine establishment was good and growth quite rapid. Since glycine spreads by means of long stems and stolons, deferment of grazing is often recommended to encourage improvement of a sparse stand.

The aim of the present experiment was to investigate the effect of different rates of sowing of green panic and glycine on germination, survival and productivity over the initial 2 years, when defoliation was deferred for a period in the second year.

II. MATERIALS AND METHODS

The experiment was carried out on a fertile red basaltic loam with a history of 12 years of lucerne followed by 4 years of cropping.

All combinations of 3, 6 and 9 lb of glycine per acre and the same sowing rates of green panic were used in a 3 x 3 x 4 randomized block design. Plot size was 16 ft x 16 ft. Seed was mixed with sawdust, hand-broadcast on February 20, 1961, covered by raking and lightly rolled. Dry weather necessitated irrigation on February 28 and March 10. The germination x purity factor (laboratory) was 6·6% for green panic and over 50% for glycine.

Dense and vigorous growth of *Nicandra physalodes* and other weeds necessitated cutting and removal of the material on April 14 (height 9 in.), May 5 (height 15 in.) and September 26 (height 6 in.). Thereafter, weeds were practically non-existent. Other mowings were given on December 11, 1961, following sampling; on January 10, 1962, and February 12, 1962, to remove heavy growth of grass when lack of time prevented sampling; and in August 1962, following sampling at the end of the period of deferment.

Population counts and yield estimates were made on September 22, 1961; December 6, 1961; August 2, 1962; and January 29, 1963; an additional population count was made on March 23, 1961, to estimate germination. In August 1962, yield estimates were made of glycine only, since the 5½-month deferment had resulted in lodging and death of a large part of the green panic shoot.

For the estimates in March and September 1961, ten 2 lk x 2½ lk quadrats were randomly located. For subsequent estimates a quadrat 9 ft x 6 ft was placed in a fixed position near the centre of each plot.

When both species were sampled, individual yields were determined. Glycine yields were estimated on an oven-dry basis. Green panic yields were estimated on an oven-dry basis in September 1961 but on an air-dry basis in December 1961 and January 1963.

III. RESULTS

(a) Plant Populations

Survival figures for green panic and glycine are given in Tables 1 and 2.

Emergence.—Emergence, as estimated in March 1961, was 3–4% for green panic and 16–18% for glycine. More glycine seed probably germinated and emerged after the March counts were made, but survival of the seedlings under the dense sward would have been negligible.

Increased seeding rates resulted initially in higher plant density, with initial green panic populations higher than the corresponding ones of glycine.

TABLE 1

SURVIVAL OF GREEN PANIC PLANTS BETWEEN MARCH 1961 AND JANUARY 1963

Treatment (lb/ac)	Mean Numbers of Plants per 100 sq lk					Percentage Survival	
	Mar. 1961	Sept. 1961	Dec. 1961	Aug. 1962	Jan. 1963	Dec. 1961	Jan. 1963
Green panic 3	90·2	79·5	75·5	65·1	63·8	84	71
Green panic 6	172·8	131·8	128·9	102·2	93·0	75	54
Green panic 9	229·0	205·0	153·8	112·9	108·7	67	47
Glycine 3 ..	153·8	127·8	110·7	94·5	90·1	72	59
Glycine 6 ..	171·0	156·8	123·9	97·4	90·2	72	53
Glycine 9 ..	167·2	131·7	123·7	88·2	85·2	74	51
L.S.D. 5%	27·7	18·6	12·8	13·3	12·6		
L.S.D. 1%	37·6	25·2	17·3	18·1	17·1		
	C≫B≫A	C≫B≫A	C≫B≫A*	B, C≫A	C>B≫A		
		b≫a, c	b, c>a				

* In December, the interaction term is significant; the difference between 9 and 6 lb/ac green panic rates is not apparent at the 6 lb/ac glycine rate.

Treatment Code: A,B,C green panic; a,b,c glycine.

TABLE 2

SURVIVAL OF GLYCINE PLANTS BETWEEN MARCH 1961 AND JANUARY 1963

Treatment (lb/ac)	Mean Numbers of Plants per 100 sq lk					Percentage Survival	
	Mar. 1961	Sept. 1961	Dec. 1961	Aug. 1962	Jan. 1963	Dec. 1961	Jan. 1963
Green panic 3	103·3	42·8	30·9	17·5	11·4	30	11
Green panic 6	113·2	36·3	25·5	12·8	7·5	22	7
Green panic 9	105·2	33·3	21·2	8·8	4·4	20	4
Glycine 3 ..	57·2	20·0	13·3	8·8	5·7	23	10
Glycine 6 ..	105·7	37·8	23·8	12·2	6·6	23	6
Glycine 9 ..	158·8	54·7	40·6	18·2	11·1	26	7
L.S.D. 5%	20·1	8·3	8·4	5·7	3·5		
L.S.D. 1%	27·3	11·2	14·5	7·7	4·8		
	c≫b≫a	c≫b≫a	c≫b>a	c≫a; c>b	c≫a; c>b		
		A>C	A>C	A≫C	A≫C; A>B		

Treatment Code: A,B,C green panic; a,b,c glycine.

Survival of green panic.—Green panic density decreased with time. Higher plant populations resulting from increased seeding rates persisted to the end of the experiment, but the greatest percentage decline occurred in the highest populations. Population decline was slow by the end of the experiment. Glycine had no consistent effect on green panic survival and the differences for September and December 1961 are regarded as due to chance variations in germination.

Survival of glycine.—Populations of glycine declined in all treatments but the decline was greatest where initial populations were highest. The effect of increased seeding rates on plant density persisted throughout the first year but was less marked in the second. The greatest decline occurred between March and September, and by the end of the first year populations were low and further decline virtually ceased.

Glycine survival was affected by both its own density and that of the grass. From September 1961 to the end of the experiment the survival of glycine was significantly higher where the grass was least dense. At the end of the experiment, the final density of glycine plants was still significantly higher in the 9 lb/ac plots, but only at the 3 lb and 6 lb/ac grass seeding rates.

(b) Herbage Yields

Herbage yields are given in Tables 3 and 4.

Green panic.—At the September 1961 harvest, grass dry-matter yield was higher with increasing sowing rate. The grass wilted before the sampling date, so lack of soil moisture prevented yields of grass from low seeding rates eventually reaching those from the highest. A combination of rain and irrigation in October and November allowed a ceiling yield of nearly 5,000 lb of air-dry grass per acre to be attained; this was independent of grass population density. These ceiling yields, however, were attained only in plots having the fewest glycine plants. Green panic yields were lower in plots of the highest glycine seeding rate, and this was probably an effect on the yield per plant. It is likely that further high yields would have been obtained during the remainder of the summer had measurements been made, since the area had to be mown twice to prevent the grass from crowding out the legume. The high grass yields obtained in January 1963 show that the soil was still highly productive two years after the grass was sown, and at this stage yield per plant was still inversely related to plant density.

TABLE 3

YIELDS OF GREEN PANIC

Treatment (lb/ac)	September 1961 (oven-dry)		December 1961 (air-dry)		January 1963 (air-dry)	
	lb/ac	g/plant	lb/ac	g/plant	lb/ac	g/plant
Green panic 3 ..	1,036	6	4,860	29	3,690	27·2
Green panic 6 ..	1,444	5	5,180	18	3,520	18·7
Green panic 9 ..	1,825	3	5,330	16	3,390	15·2
Glycine 3	1,300	4·7	5,470	22	3,640	20·4
Glycine 6	1,729	5	5,180	19	3,260	19·2
Glycine 9	1,276	4·4	4,720	17	3,710	21·5
L.S.D. .. 5% / 1%	Not analysed	Not analysed	570 775 a > c	Not analysed	N.S.D.	4·2 5·7 A≫B, C

Treatment Code: A,B,C green panic; a,b,c glycine.

Glycine.—Yields of glycine were negligible at the September 1961 harvest and low for December. On the latter occasion, yields increased with increasing green panic seeding rate. Lower yields per glycine plant are indicated. The effect of grass seeding rates was again apparent in August 1962, when some plots gave good glycine yields, but it had disappeared by the end of the experiment.

TABLE 4

YIELDS OF GLYCINE

Treatment (lb/ac)	December 1961		August 1962		January 1963	
	lb/ac	g/plant	lb/ac	g/plant	lb/ac	g/plant
Green panic 3 ..	55	0·8	1,110	27·9	246	10·8
Green panic 6 ..	20	0·7	695	26·8	147	9·9
Green panic 9 ..	10	0·3	450	28·1	117	11·0
Glycine 3	13	0·4	520	25·2	81	6·5
Glycine 6	30	0·5	870	33·8	223	15·2
Glycine 9	42	0·5	860	23·8	205	10·0
L.S.D. .. 5%	13	Not analysed	387	..	113	5·8
L.S.D. .. 1%	17		523	..	153	7·8
	A≫B, C b, c≫a		A≫C; A>B	N.S.D.	b, c,>a	b≫a

Treatment Code: A,B,C green panic; a,b,c glycine.

An unusual result was that glycine gave a significantly greater yield per plant in the plots of the intermediate seeding rate.

Effect of deferment on glycine growth.—During the period of deferment from mid February to early August 1962, rainfall was adequate except for a short period in May and early June.

By August, plant populations had become practically stabilized in the two species, but they did not always simply reflect the original differences in planting rate (hence high LSD's in Table 4). Although the treatment means for the August harvest in Table 4 show a wide range of glycine yields, the range over individual plots was very much wider, some being excellent and others very poor. It is therefore of interest to plot glycine density against yield at the end of the spelling period, using individual plot data (Figure 1). The result is a reasonably good linear relationship ($r = 0 \cdot 734$; 34 D.F.). Where glycine population densities were less than 10 per 100 sq lk, legume yields remained poor after spelling. Where legume populations were 20–30 plants per 100 sq lk, high yields with a good ground cover almost invariably resulted. Plant populations of 10–20 per 100 sq lk might be regarded as intermediate for success with deferment.

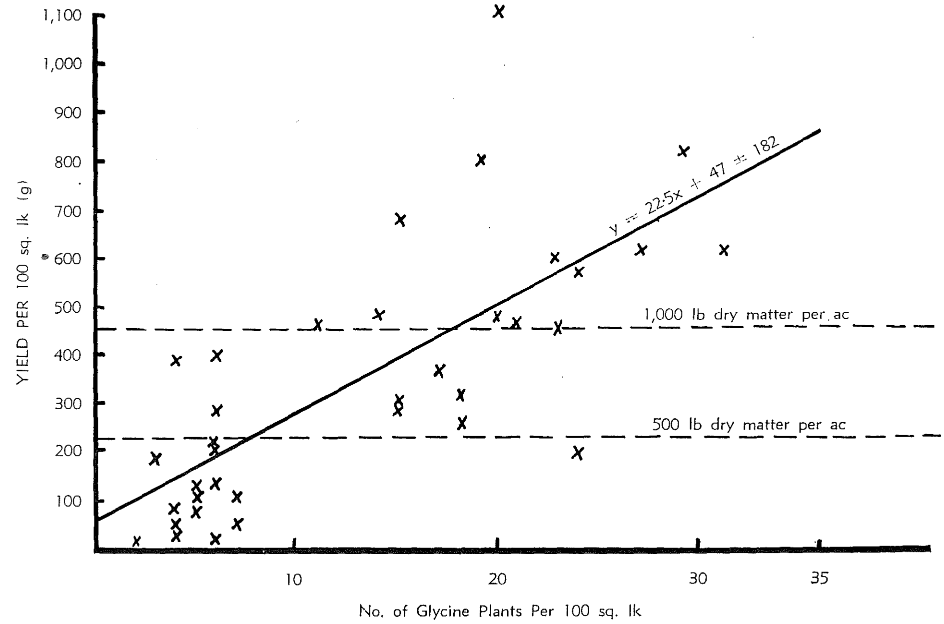

Fig. 1.—Relationship between population density and oven-dry yield of glycine in August 1962, following 5½ months' deferment.

In well-established pastures on the Research Station, Tinaroo glycine is characterized by large numbers of rooted runners. However, by the end of the present experiment glycine had developed rooted runners in only three of the 36 plots. These were in the 3 lb green panic/3 lb glycine, and 3 lb green panic/9 lb glycine treatments, and at that stage only a few new root systems were found within the quadrat area.

IV. DISCUSSION

(a) First Year

Grass and legume seeding rate markedly affected both the survival and the yield of individual plants. The heavy first-season growth of grass and weeds resulting from high soil fertility is believed to have been the first cause of the mortalities. Dry weather between June and November could have aggravated the effect of shading and contributed to the mortalities recorded up to December.

Green panic survival was much better than that of glycine, and even at its final density it could compensate for lower numbers by increased growth per plant. Glycine mortality was high. Although the stand was mown fairly regularly, dense shading occurred for periods of several days between mowings and glycine yields were always low. The high relative growth rate of green panic as compared with glycine has been reported elsewhere (Tow 1967) and *Nicandra* appears to be even more vigorous than green panic. Significantly better survival and growth of glycine were obtained with the lowest grass populations, and this suggests that better legume performance could have been obtained at even lower grass seeding rates. Although legume mortalities were proportionately higher at higher legume seeding rates, the higher seeding rates were still advantageous because they resulted in higher densities and yields.

Under conditions of continuously high levels of mineral nitrogen availability (as in the present experiment) de Wit, Tow, and Ennik (1966) have shown that established glycine plants have a good competitive ability in relation to green panic. In the present experiment this proposition was not really tested because the large numbers of legume plants which died in the first year had probably never become properly established. ("Establishment" is used here in the sense of being developed past the seedling stage. In the case of glycine this probably means being at least partly reliant on symbiotically-fixed N and possessing some of the side branches which develop low down on the plant after the appearance of the fourth or fifth leaf. It has often been observed that shading by grass suppresses the development of these lower branches.)

The high susceptibility of glycine to grass and weed competition in the first months after sowing is regarded as the crucial factor to consider in management, for once the glycine plants had become firmly established they should have grown quite satisfactorily with the heavy stand of grass. The difficulty lies in the establishment of glycine in such stands at adequate population densities. Legume survival rate may be higher with lower initial availability of nitrogen. However, de Wit, Tow, and Ennik (1966) have shown that at both high and low levels of available soil nitrogen green panic competes strongly with glycine before the latter begins to fix nitrogen. High green panic densities may therefore always have an initial adverse effect on glycine growth.

(b) Second Year

In the absence of a dense stand of grass, young stands of glycine spread readily by means of rooted runners. In the present experiment, with high populations of grass, widely different degrees of success were achieved with deferment. Even in the case of fertile soils it appars that there is a minimum density of glycine plants required to obtain a good cover of the legume even after a long period of deferment. This phenomenon parallels the experience of farmers, and account should be taken of it in practice. In the plots where legume populations were very low, it would have been of more practical value to make regular use of the satisfactory stand of grass, including the use of fertiliser nitrogen.

Though the deferment was successful in some plots, only a very limited number of new root systems developed from runners. The stand of grass preventing regular contact of runners with the ground may be held responsible. The August mowing provided a considerable setback to the legume and as a result yields in January 1963 were low. It is not unusual to obtain low yields of glycine from early summer growth of mixed pasture, and eventual recovery of the legume might be expected. However, if the deferred pasture had been lightly grazed in August instead of being mown, better summer performance of the legume may have resulted, and trampling by stock may have enabled some of the runners to make contact with the soil. This should have resulted in the development of new root systems from the nodes during wet weather.

(c) Total Productivity

In the present experiment, careful management was still required 2 years after sowing in order to achieve a balanced grass-legume mixture. One aim of growing a grass and a legume together is to achieve higher productivity than by growing one or the other alone. On a fertile soil the present experiment showed that over the first 2 years the legume made no appreciable contribution to total yield except where grass production was sacrificed to allow for a long period of deferment. On the other hand, even with the adverse effects of weeds and of a dry winter and spring, green panic was able to maintain sufficiently dense populations to achieve good light interception and high yields of dry matter.

More efficient early management may have achieved better establishment of glycine. It is also possible that the use of lower grass seeding rates to avoid serious setbacks to the legume could have had the effect of keeping total productivity at a lower level. In addition, chemical weed control would have remained a problem in the first year because of legume susceptibility to most herbicides.

Therefore, in the present experiment on a fertile, high-nitrogen soil, maximum productivity would have been achieved over the 2 years, with less trouble, if the green panic had been grown without glycine as a legume constituent. In practice, it is important to decide to what extent lower initial productivity, higher management requirements and some risk of failure can be accepted in order to gain the long-term benefits of green panic-glycine mixtures.

V. ACKNOWLEDGEMENTS

I wish to thank Mr. R. Walker for technical assistance, the Biometrics Branch of the Department of Primary Industries for statistical analyses, and Mr. R. W. George for some statistical work.

REFERENCES

DE WIT, C. T., TOW, P. G., and ENNIK, G. C. (1966).—Competition between legumes and grasses. *Agric. Res. Rep.* No. 687.

TOW, P. G., (1960).—Some ways of establishing glycine. *Qd Agric. J.* 86:425.

TOW, P. G. (1967).—Controlled climate comparisons of a tropical grass and legume. *Neth. J. Agric. Sci.* 15 (2).

(Received for publication October 5, 1966)

The author is an officer of the Agriculture Branch, Division of Plant Industry, Department of Primary Industries, and is stationed at Kairi Research Station.