Agronomic Characteristics of Green Panic, *Panicum maximum* var. *trichoglume* Eyles

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Forage crop production has increased yearly in Japan, but there is a difficulty in assuring stable production with high yields in the summer season in warm districts. Temperate grasses suffer seriously from summer growth depletion, while corn and sorghum now widely grown have disadvantages such as lodging and restricted time of harvesting. Therefore, tropical grasses that grow vigorously at high temperature and tolerate drought, such as Rodesgrass etc., have been examined. As the genus *Panicum* shows large variaitons, being composed of many species, varieties and lines, it is expected that studies on this genus may be rewarding. From this point of view, agronomic characteristics of green panic, which seemed to represent medium features of the genus, were studied.

Green panic is widely grown in many tropical and subtropical areas of the world for grazing, green forage, hay and for silage. In Australia, this crop is used as a standard in studying tropical grass forages.

In Japan, this crop is to be used as a summer crop, because it does not survive in winter except in Okinawa. Dry matter yield of 100 (in southern Kanto) to 200 kg/a (in Kyushu) is expected. Features of the crop are: thin stems, profused tillering, slow lignification after heading, uniform heading as compared to other species of the genus, 5–6 kg/a of seed production expected, and apomixis with less variations. Thus, the crop seems to be promising. On the other hand, it is less competitive to weeds such as *Digitaria adscendens*, etc., due to slow germination and seedling growth of the crop, suggesting the need of weed control measures for promoting seedling establishment.

Already in Kyushu, there are several examples of green panic cultivation. However, it is strongly desired to clarify agronomic characters related to its cultivation, such as seed germination and seedling growth.

Germination, emergence and sowing method

1) Effect of physical factors on germination and seedling growth (Table 1)

(1) Temperature: Temperature suitable for germination was 20–30°C, with 25°C as optimum. Fully ripened seeds showed high germination percents even at 10°C, though it took long time. Plumule elongation was faster under higher temperature (highest temperature used was 37°C), and at 20°C the plumules reached 1 cm (depth of soil cover) at 2–3 days after germination in case of better elongation. Elongation at temperatures below 20°C was very slow. Particularly at 15°C more than 7 days were required to reach 1 cm, resulting in low percent emergence caused by drying and wetting of soil as well as diseases and insect pests occurred during that period.

After the plant height exceeded 20 cm, the maximum growth in plant height occurred at 30°C, and slower growth beyond that temperature. This seems to be related to amount of respiration and greater root weight at lower temperature (lowest temperature used was 17°C).

Table 1. Effects of temperature and solar radiation on seedling growth (1970)

Temperature (℃)	Radiation $\left(\frac{cal}{cm^2 \cdot day}\right)$	Plant height (cm)	No. of leaves on a main stem	No. of tillers per pot	No. of roots per plant	D. M. (mg/pot)		
						Top	Root	T/R
26	170	25. 1	5. 7	0	3. 8	856	169	5. 1
(21)*	34	11. 3	3. 8	0	1. 0	81	17	4. 7
23	190	23. 7	6. 0	5. 0	4. 5	1159	344	3. 4
(26)*	38	12. 9	4. 0	0	2. 0	133	35	3. 8
29	200	23. 5	6. 8	22. 3	5. 3	1894	560	3. 4
(33)*	40	16. 0	4. 5	0	2. 0	231	69	3. 4
17	170	25. 2	8. 8	33. 7	7. 1	2259	1266	1. 8
(67)*	34	20. 6	5. 8	0	2. 5	341	58	5. 9

*Figures in ( ) show days from sowing to investigation.

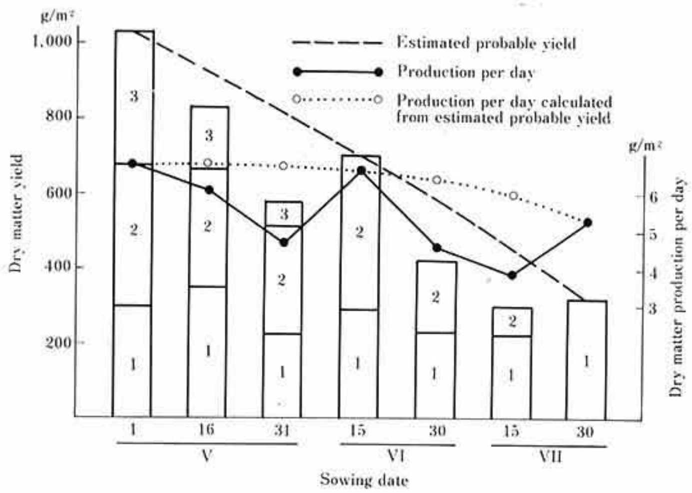

Fig. 1. Relation between sowing date and dry matter yield (Result of experiment in Chiba City, 1969, by Okada)

(2) Solar radiation: Dry matter yield was greater with larger solar radiation, although plant height showed no difference at levels beyond 100 cal/cm² of mean daily solar radiation. With solar radiation below 40 cal/cm², growth was retarded with no tillering and extremely few adventitious roots.

(3) Soil moisture: Experiments using top soil of volcanic ash soil (field water capacity = 67% on dry soil basis) indicated that optimum moisture content for emergence was 45–55%, but moisture content more than 60% was needed for seeds harvested in the previous year. In some cases, number of emergence was very much reduced by being exposed to 35% soil moisture only for 1 day, while in another case a better emergence than at the optimum moisture was obtained by exposing to higher moisture content after being kept at 40–50% for 1–3 days. Further seedling growth was not influenced greatly by soil moisture content that is not adverse to emergence.

2) Sowing method

Based on the above results and experiments on sowing method, following method is proposed.

(1) Sowing time (Fig. 1): In case when effects of weeds can be neglected, the earlier

the sowing date, the greater was the yield (but dry matter yield per day was almost similar except too late sowing). Therefore, the time when daily mean temperature reaches 17°C is suitable for sowing. However, if it is expected that minimum temperature goes down below 10°C, the sowing should be delayed to avoid the adverse effect on emergence. Sowing at the daily mean temperature higher than 20°C has some effect on overcoming weeds.

(2) Broadcasting vs row sowing: Weeding can be done easily with row sowing, but yield of first cutting in case of early harvesting is more or less low when distance between rows is wider than 50 cm.

(3) Seed rate and sowing depth: Seed rate of 50 g/a is enough to get 200–250 plants/m^2 at 50% of germination, but to assure uniform emergence and better initial growth 100–200 g/a of seeds are used. Seeding depth be about 1 cm when there is no soil moisture deficiency.

Germination, emergence, and fertilizer application (Table 2)

1) Effect of fertilizer on germination and seedling growth

(1) Germination is generally not influenced by soil pH alone.

(2) Nitrogen and potassium inhibit emergence sometimes. Critical concentration is 0.2 gN and 0.2 gK per 100 g of dry soil (mentioned above) at 60% of soil moisture. The concentration corresponds to 10 mmho/cm of specific conductivity and osmotic pressure of 3.5 atm. Thus, the salt damage apt to occur at low soil moisture. Heavy application of urea as a basal dressing causes the damage not only by increased concentration of soil solution but also by increased pH and generation of gaseous ammonia.

(3) Nitrogen causes a slight damage to the seedling growth even within a range of concentration not causing damage to emergence. Critical level is 0.1 g N/100 g dry soil at 60% of soil moisture. On the contrary, potassium promotes seedling growth at the concentration not detrimental to emergence (potassium applied to germinated seeds in a Petri's dish apparently promoted plumule elongation). Phosphate fertilizer application concentrated to the vicinity of seeds also promotes seedling growth.

2) Method of basal dressing

In order to avoid damage to emergence, the following methods are practiced.

(1) Slow-release fertilizer such as granular fertilizer is broadcast.

(2) Sowing date should be decided in order to keep soil moisture at the level of field capacity by the time of full emergence (3–10 days after sowing), by considering expected rainfall etc. If soil moisture shortage is expected, fertilizers are applied to a depth of 5–10 cm.

(3) Phosphate causes no salt damage. Superphosphate is applied singly beneath the seed beds, if possible, when sowing is done under low temperature, because it promotes initial growth.

(4) Total amount of N and K_2O to be applied is determined on the basis of nutrient absorption, as follows:

i) With a target of about 80 cm of plant height and harvesting every 20 days, a rate of 600 g N/a and 500 g K_2O/a is used, as-

Table 2. Effect of fertilizers on seedling emergence (%)

N* (g)	$(NH_4)_2SO_4$	NO_3NH_4	Urea	P* (g)	$Ca(H_2PO_4)_2H_2O$	Fused phosphate	K* (g)	K_2SO_4	KCl
0.1	33	36	38	0.5	36	31	0.2	32	32
0.2	34	29	19	1	38	23	0.5	30	13
0.3	17	29	7	2	36	30	0.8	9	0

* Amounts of N, P, K are shown per 100g of dry soil

suming 20 kg/a of dry matter yield per cutting.

ii) With a target of about 1 m of plant height and cutting every 30 days, 1 kg N/a and 700 g K_2O/a are applied, assuming 40 kg/a of dry matter yield per cutting.

iii) With a target of about 1.3 m of plant height and cutting every 60 days, 1.1 kg N/a and 830 g K_2O/a are used, assuming 55 kg/a of dry matter yield per cutting.

iv) The above figures are approximate estimation for the 1st cutting and peak growth stage under a good condition. In cool autumn season, cutting interval is increased or fertilizer dosage is reduced.

(5) Phosphate is applied as basal dressing, because of large initial absorption. Attention should be paid to phosphate absorption coefficient of soil. To volcanic ash soil, a rate of 2–3 kg P_2O_5/a is generally optimum.

Method of harvesting and yield

1) Time of harvesting (an interval of cutting). Early cuttings (frequent cuttings) favours TDN and crude protein yields whereas late cuttings (less frequent cuttings) favours dry matter yield and TNC (total nonstructural carbohydrates) yield (Table 3). Interval of cutting more than 20 days is desirable, because regrowth is retarded by shorter intervals (Table 4). On the other hand, too long intervals at the peak growth stage causes yellowing and lodging of plants, and they are replaced by new leaves regenerated from the base of the plants. The plants become liable to lodge due to rainfall after the heading stage: a factor to be considered in determining time of harvest.

2) Height of cutting. In general, the

Table 3. Effect of cutting on yield and absorption of nitrogen and potassium
(Result of experiment at Chiba City in 1968, by Okada)

Cutting frequency	Cutting date	D. M. yield (g/m^2)	TNC* yield (g/m^2)	Plant height (cm)	N absorption (g/m^2)	K absorption (g/m^2)
4	24/VII	190	14.8	98	7.0	6.3
	12/VIII	204	20.4	80	6.1	4.4
	4/IX	177	11.7	75	5.5	3.9
	9/X	186	11.4	79	5.6	4.7
	Total	757	58.3		24.2	19.3
3	31/VII	400	27.6	115	10.4	7.2
	4/IX	281	15.5	96	7.1	6.5
	9/X	159	11.3	79	5.2	5.2
	Total	840	54.4		22.7	18.9
2	7/VIII	544	38.6	138	11.3	7.0
	2/X	539	32.3	126	10.5	11.0
	Total	1083	70.9		21.8	18.0

*Total nonstructural carbohydrates

Table 4. Effect of cutting on dry matter yield
(Result of experiment in Kumamoto, 1973, by Ibaraki et al.)

Cutting interval										
20 days	Cutting date	9/VI	29/VI	20/VII	9/VIII	28/VIII	19/IX	9/X	29/X	Total
	Yield (kg/a)	0.6	36.2	36.7	20.1	46.7	15.2	12.3	5.9	173.7
30 days	Cutting date	19/VI	30/VII	18/VIII	19/IX	19/X	29/X	Total		
	Yield (kg/a)	7.8	89.6	52.3	30.7	5.2	1.8	187.4		
40 days	Cutting date	29/VI	9/VIII	19/IX	29/X	Total				
	Yield (kg/a)	28.9	85.0	46.3	5.5	165.5				

Table 5. Digestible nutrients per dry matter (%)
(Result of experiment in Saitama, 1972, by Abe et al.)

Cutting date	Stage	C. P.	E. E.	N. F. E.	C. E.	TDN
16/VII	Vegetative	16.8	2.1	26.9	17.3	65.7
31/VII	Prs-heading	11.0	1.3	27.3	20.9	61.9
10/VIII	Florescense	7.5	0.7	24.9	16.3	51.5
16/VII	1st cutting	14.9	1.8	27.7	17.8	64.5
6/VIII	2nd 〃	15.2	1.6	25.7	19.3	63.7
25/VIII	3rd 〃	16.1	2.3	24.5	18.9	64.8
19/IX	4th 〃	12.9	1.5	22.8	18.6	57.7

higher the cutting, the faster is the regrowth, but the difference becomes small at about 30 days after cutting.

There is a report that low cutting at 5 cm of height will do, but it is practical to cut at 10–15 cm in case of an interval of about 30 days in the summer season.

3) Content of digestible nutrients. Content of digestible nutrients as related to cutting is given in Table 5.

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