N Study on Maize Planting Technique of Wide/Narrow Alternation with High Stubble (MPWNL)

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The technology of maize planting in width line and narrow line alternately has been being studied for many years. The results showed that the technology may improve soil environment; promote maize growth; enhance amount of roots, leaf area; foster ability of soil production; reduce invested capital of the production; enhance maize yield; and increase economic benefit.

Key words: Maize, technique of wide/narrow planting, high stubble, planting technique of alternation, research

Operation procedures of maize planting in wide line and narrow line alternately present uniformly ridge with 65cm width in a field which is altered to wide ridge with 90cm width, and narrow ridge with 40cm width. Maize is planted in the narrow ridge. Fertilizer application and loosing the soil is done with top application in the width ridge. The remaining maize stalk stubbles with 40cm height on seedling strip narrow ridge are obtained during harvest time. Ploughing is done at the wide ridge with strip rotary cultivator after autumn harvest. The stubbles are returned to the field. During the second spring, seeds are planted on the wide ridge and become narrow with the growth of the seedlings. Fertilizer and soil loosening is done at top application period in the width ridge again, and year after year.

1. EXPERIMENT MATERIALS AND METHOD

1.1 Experiment site: Chaoyangpo town of Gongzhuling City in Jilin Province; experiment field area is 1 hectare; demonstration site is Chaoyangpo town of Gongzhuling City in Jilin Province; demonstration field area is 20 hectares.

1.2 Varieties of the experiment and demonstration: Simi25, Simi21, Jidan209, Laiyu3119, Jidan180, Yinhe101, Jidan342; these are the popular varieties in Jilin province.

1.3 Experiment treatments: Necessary agriculture machines, equipment, and experimental methods

The treatments:

(1) maize planting in width ridge with 90cm, narrow ridge with 40cm, remaining stubbles with 40cm height;
(2) present tilth method with uniformity ridge plant (CK)

The agricultural machinery:

(1) tractor with 804 wheel model and tractor with 18 horsepower for agriculture made by Tianjing tractor factory;
(2) double lines precision seeding-machine with 2BD-2 model;
(3) cultivation and deep loosing soil topdressing machine;
(4) strip rotary cultivator with 1GQN-320T3 model.

Experiment method: The experiment adopted big section antitheses, mechanization, and big demonstration area.

2. THE EXPERIMENT RESULTS AND ANALYSIS

2.1 Effect of maize planting in width line and narrow line alternately on soil environment

2.1.1 Soil nutrient change after maize planting in width line and narrow line alternately

Table 1 Soil nutrient change after maize planting in width line and narrow line alternately.

Treatments	Organic matter(g/kg)	Active nitrogen(mg/kg)	Active phosphorus (mg/kg)	Active potash (mg/kg)
Before first year MPWNL（CK）	23.30	204.15	30.24	115.0
Fourth year M**P**WNL	25.00	117.2	43.9	125.1
Compare with CK	+1.7	-86.95	+13.7	+10.1
Fifth year MPWNL	25.92	182.1	51.9	173.5
Compare with CK	+2.6	-22.05	+21.66	+58.5
Sixth year MPWNL	26.678	131.8	35.82	147.8
Compare with CK	+3.37	-72.35	+5.58	+32.8
Seventh year MPWNL	30.3	149.25	32.54	165.1
Compare with CK	+6.73	-54.9	+2.3	+50.1

From Table I, soil organic matter content increased by 6.73g/kg, soil active phosphorus content increased by 2.3g/kg, soil active potash content increased by 50.1g/kg, soil active nitrogen content decreased by 54.9g/kg after maize planting in wide line and narrow line alternately for seven years. Main reason of soil active nitrogen N content decrease is that some N can be consumed when maize stalks decompose and some returned to the soil during maize planting in width line and narrow line alternately.

2.1.2 The change of soil moisture content after maize planting in width line and narrow line alternately.

Table 2. Soil water content difference value between maize planting in wide line and narrow line alternately and traditional cultivated method from 1998-2005.

	1998	1999	2000	2001	2002	2003	2004	2005	平均
Before spring sowing	+1.9	+2.7	+0.7	+0.5	+0.9	+2.0	+1.3	+3	+1.63
Average of whole maize growth period	+2.1	+2.4	+1.2	+0.9	+0.5	+0.9	+1.2	+1	+1.28

From Table 7,soil water content after maize planting in wide line and narrow line alternately for seven years is 0.5-3.0 per cent more than that under present uniformity ridge plant. This water content difference value equal to 4.0-22mm more rainfall .Soil average water content of whole maize growth period is more than.0.5-2.4 per cent which is equal to 4.0-19mm rainfall.

2.2 Effect of maize planting in wide line and narrow line alternately on maize growth course

2.2.1 Maize planting in wide line and narrow line alternately can advance maize roots development.

Table 3. Maize roots change in difference treatments.

Treatments		0--20cm Roots weight(g)	20--40cm Roots weight(g)	Total(g)	Average(g)	Compare (percentage)
Width lines	First year	87.4	11.6	99.0	88.3	132.58
	Second year	82.9	3.7	86.6		
Uniform-ity ridge	First year	63.6	5.6	59.2	66.6	100
	Second year	61.0	3.0	64.0		

Maize roots growth after maize planting in wide line and narrow line alternately is better than that under maize planting in uniformity ridges. The roots' weight increased obviously; the average wind dry weight added by 32.5 per cent in 0-40 cm deep.

2.2.2 Effect of maize planting in wide line and narrow line alternately on maize leaves area growth

Table 4. Maize leaves area change in different treatments in 1999 unit：cm^2

Treatment	Jun 15	Jul 5	Jul 25	Aug 12	Aug 20	Sep 7	Sep 16
Width lines	242.9	2536	8997	8568	8445	7109	6313
Uniformity ridges	174.2	1953	7636	7310	7072	5678	3114
Compare	68.7	583	1361	1258	1373	1431	3199

Table 5. Maize leaves area change in difference treatments in 2000 unit：cm^2

Treatments	Jun 14	Jul 24	Aug 2	Sep 15
Width lines	404.3	6859.2	6728.7	5269.2
Uniformity ridges	296	6402	6247	3874.9
Compare	108.3	457.2	481.7	1394.3

Table 6. Maize leaves area change in different treatments in 2000 unit：cm^2

Treatments	Jun 8	Jul 2	Jul 16	Jul 27	Aug 9	Sep 3
Width lines	165.3	2952.2	5079.6	7907.6	7481.5	6935.5
Uniformity ridges	161.2	2695.2	4996.7	7160.8	6507	6450.1
Compare	4.1	257	82.9	746.8	974.5	485.4

Table 4 shows that the average maize leaves area per plant is less than 1361cm^2 under uniformity ridge cultivation than that under width lines cultivation when individual maize plant leaves reach biggest, less 1431cm^2 when maize silks are 45 days; the green leaves area is less than 3199cm^2.

Table 5 shows that the average maize leaves area per plant is less 457.2cm^2 under uniformity ridge cultivation than that under width lines cultivation when maize individual plant leaves reach biggest with green leaves area less 1394.3cm^2 when maize silks for 51 days.

Table 6 shows that average maize leaves area per plant is less 746.8cm^2 under uniformity ridge cultivation than that under width lines cultivation when maize individual plant leaves reach biggest , the green leaves area less 485.4cm^2 when maize silks for 46 days.

2.2.3 Effect of maize planting in wide line and narrow line alternately on maize dry matter accumulation and intensity of photosynthesis.

Table 7. The dry matter weight of different times in different treatments in 1999 (average individual plant weight) unit：g

Treatments	Jun 15	Jul 27	Aug 20	Sep 07	Sep 16	Sep 25
Width lines	4.33	171	325.8	378.5	506.7	528.3
Uniformity ridges	3.33	138.4	291.7	332.4	454.9	475.4
Compare	+1.0	+32.6	+34.1	+46.1	+51.8	+52.9

Table 8. The dry matter weight of different times in different treatments in 2000 (average individual plant weight) unit: g

Treatments	Jun 14	Jul 24	Aug 2	Sep 15
Width lines	404.3	6859.2	6728.7	5269.2

Uniformity ridges	296	6402	6247	3874.9
Compare	108.30	457.20	481.70	1394.30

Table 9. The dry matter weight of different times in different treatments in 2001 (average individual plant weight) unit: g

Treatments	Jun 8	Jun 28	Jul 20	Jul 23	Sep 26
Width lines	1.9	26.1	110.1	130.6	455.4
Uniformity ridges	1.4	22.3	105.6	112.1	426.5
Compare	0.5	3.8	4.5	18.5	28.9

From Tables 7 to 9, maize dry matter accumulation under width lines cultivation is higher than that under uniformity ridges from seedling period to elongation stage; curves of maize dry matter accumulation in different years are basically identical.

Table 10. Intensities of photosynthesis in different treatments unit：$(d.m^2)/hm^2$

Treat-ment	Seedling-elongation	Elongation to staminate flower	Staminate flower to silk	13days after silk	Silk from13 days to 38 day	From silk 38days to mature	Photosynthesis intensity of whole growth time
Width lines	179309.6	258624	328576.2	460134.1	808977.5	421062.2	2456683.6
Uniform-ity ridges	153975.4	231526.2	287524.9	406667.2	795033.3	356212.5	2230939.3
Compare	25334.2	27097.8	41051.3	53466.9	13944.2	64849.7	225744.3

From Table 10, it is shown that t photosynthesis intensity of whole maize growth time under width lines cultivation is high 225744.3$(d.m^2)/hm^2$ than that under uniformity ridges.

2.3 Maize planting in wide line and narrow line remaining high stubbles alternately can increase soil organic matter content.

Table 11. Weight of maize straw returned to field by remaining high stubbles. unit: g

	Straw weight of average individual plant	Straw weight of 10cm stubble	Straw weight of 40cm stubble	10cm %	40cm %	Increased weight of 40cm %
Wet weight of Simi21 straw	2858	219.1	874.1	7.6	30.6	23
Wet weight of Simi25 straw	3002	247.2	986.4	8.2	32.9	24.7
Wet weight of 1243 straw	2100	201.4	802.1	9.6	38.2	28.6

Wet weight of Laiyu3119 straw	3900	309.3	1235.2	7.9	31.7	23.8
Wind dry weight of Simi25 straw	206	10．9	46	5．3	22.23	16．93

Wind weight of 2.78t/ha maize straw will be returned to the field per year by the remaining high stubbles base on least wind weight of Simi 25 straw. Nutrient content of Simi 21, Simi 25 straw is that full nitrogen: 6.71g/kg, full phosphorus: 2.332g/kg, full Potassium 11.399g/kg, then equal to fertilizing urea 40.57kg/ha.

2.4 Effect of maize planting in wide line and narrow line alternately on maize yield

Table 12. The yield results Variety: Simi 25

Treatments	Years	Yield per hectare(kg/ha)	Range of increasing production (per cent)	Economy coefficient (per cent)
Width lines	1997	11869.1	115.5	53.6
	1998	11796.0	117.2	54.1
	1999	12693.0	115.2	53.9
	2000	9122.0	114.4	-
	2001	8363.4	110.8	53.2
	2002	9731.1	116.4	-
	2003	9977.0	117.5	52.1
	2004	8959.0	104.9	-
	2005	8928.6	110.9	50.8
	Average	10159.9	113.6	53.0
Uniformity ridges（CK）	1997	10276.3	100	51.1
	1998	10064.8	100	50.2
	1999	11018.2	100	51.0
	2000	7973.8	100	-
	2001	7548.2	100	51.3
	2002	8360.1	100	-
	2003	8489.6	100	51.8
	2004	8539.2	100	-
	2005	8053.8	100	48.2
	average	8053.8	100	48.2
That of width lines compared with CK		+1235.0	+13.6	+2.4

From Table 12, the average maize yield per hectare increased by 13.6 per cent under width lines cultivation than that of CK from 1997-2005 except 2004. The main reasons for increasing production are to select dense-endured varieties and increase plant density.

Table 13. The yield of demonstration varieties and CK Site: Chaoyangpo town

Years	Tilth methods	Varieties	Yield per hectare (kg/ha)	Compare yield (per cent)
2001	Present Tilth methods (CK)	Simi25	8264.7	100.0
	Width lines	Jidan209	9806.3	118.7
		Simi25	9712.3	117.5
		Simi21	9643.8	116.7
		Laiyu3119	8839.5	107.0
		Jidan180	8678.0	105.0
	Average		9336.0	113.0
2002	Present tilth methods (CK)	Simi25	9243.8	100.0
	Width lines	Haoyu9	10395.8	112.5
		Simi25	11127.0	120.4
		Jidan209	10328.3	111.7
		Fayu No.1	10609.8	114.8
		Yuandan22	9873.7	106.8
		Laiyu3119	11676.1	126.3
		Tiedan14	9228.2	99.8
		Jidan342	10521.3	113.8
	Average		10470.03	113.3
2003	Present tilth methods (CK)	Yinhe101	8670.0	100
	Width lines	Yuandan22	9851.4	113.6
		Yinhe101	9787.5	112.9
		Simi25	9693.6	111.8
	Average		9777.5	112.7
2004	Present tilth methods (CK)	Simi25	8840.0	100
	Width lines	Jidan260	10003.0	113.0
		DenghaiNo9	10247.6	115.9
		Simi25	8904.2	100.7
		Sidan111	8957.4	101.3
		Yinhe101	10074.5	114.0
		Jidan29	10645.9	120.4
	Average		9805.4	110.9
2005	Present tilth methods (CK)	Yinhe101	7900.2	100
	Width lines	Yinhe101	8854.0	112.1
		Jidan260	8973.5	113.6
		Simi25	9251.1	117.1
		Changcheng799	8611.2	109.0
		Jidan137	7839.8	99.2
	Average		8705.9	110.2

From Table 13, there were five demonstration varieties in 2001, yield per hectare of same varieties increased 17.5 per cent more than that of CK, yield per hectare of

different varieties increased 13 per cent more than that of CK.

There were 8 demonstration varieties in 2002, yield per hectare of same varieties increased 20.4 per cent more than that of CK; yield per hectare of different varieties increased 138 per cent more than that of CK. There were 4 demonstration varieties in 2003, yield per hectare of same varieties increased 12.9 per cent more than that of CK; yield per hectare of different varieties increased 12.7 per cent more than that of CK. There were 7 demonstration varieties in 2004, yield per hectare of same varieties exhibited no difference compared with that of CK; yield per hectare of different varieties increased 10.9 per cent more than that of CK.. There were 5 demonstration varieties in 2001, yield per hectare of same varieties increased 12.1 per cent more than that of CK, yield per hectare of different varieties increased more 10.2 per cent more than that of CK.

2.5 Analysis on the cost of maize planting in width lines and uniformity ridges.

Table 14 . Cost comparison in field task unit: Yuan renminbi/ha

Plant styles	Leveling up ground	Seed	Seeding	Field management	Total	Cost saving
Planting in width lines	Autumn rotary cultivation 100	200	Machine seeding 100	Weeding 150 Deep loosing and top dressing 100	650	--
Turning up, harrowing the soil and seeding	Turning up and harrowing 260	300	Machine seeding 100	Weeding 150 Two times cultivation and topdressing 200	1010	-360
Destroying stubbles ridging	Destroying stubbles and ridging 230	300	Livestock force machine seeding 100	Weeding 150 Two times cultivation and topdressing 200	980	-330

From Table 14, it can be seen that planting maize in width lines may decrease production cost by 330-360 Yuan Renminbi per hectare than that of CK except increasing yield and fertilizing soil.

3. CONCLUSION AND DISCUSSION

(1) Planting maize in width lines can foster soil improvement; promote maize growth; advance amount of the roots, leaves, soil area; elongate green leaves time.
(2) Planting maize in width lines may save cost by 330-360 Yuan Renminbi and increase yield by 10 per cent than that of CK.
(3) Remaining high stubble with 35-45cm during autumn harvest in planting maize in width lines.
(4) Loose soil depth of about 30-40 cm.
(5) Deep loosing time, depth and width need further study under different conditions.

4. REFERENCES

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