УДК 631.51.021:631.423.2

MOISTURE SUPPLY OF SUGAR BEET, SPRING BARLEY AND MAIZE UNDER DIFFERENT SOIL TILLAGE IN CROP ROTATION

O.S. Kozubenko,
P.V. Kostohryz, Candidate of Agricultural Sciences

The research results concerning the influence of different variants of soil tillage in crop rotation on moisture supply of sugar beet plants, spring barley and maize during their vegetation are presented.

The main task of soil tillage is the creation of optimal conditions for receiving sprouts and their intensive growth and development which is facilitated mainly by the availability of sufficient amount of moisture. That is why soil tillage has to promote water saturation, rational utilization of moisture by plants and prevention of its waste because of evaporation. Especially urgent the question is in subzones of unstable and insufficient moisture of Forest-Steppe of Ukraine where available moisture in the soil is the main prerequisite of gaining high yields.

The issue of moisture soil regime and the ways of its regulation, one of which is soil tillage, is of interest for many researchers. At present there is no concurrent frame of mind regarding this problem as different ways of tilling the soil influence differently the accumulation and retaining moisture in the soil in various soil-climatic conditions. Thus, in the researches of M.V. Kolomiets [1], U.B. Lohachov [2], S.M. Tymoshenko, V.V. Verbytskyi [3] and N.M. Zholinskyi [4] more moisture was accumulated after moldboard plowing, while according to the results of the research conducted by the researchers of the Ukrainian agricultural academy [5], Donetsk erosion-preventive station [6] and S.P. Tanchyk [7] – after no-tillage. According to the data by V.N. Sheptukhov, M.M. Halkina, A.F. Nesterova [8] and V.Kh. Yakovlev [9] no-tillage had advantages in this respect. Together with this, in the researches carried out by Erastivska research station [10], Rosivska research station of the Research Institute of Maize [11] and Lviv State Agrarian University [12], different methods of soil tillage did not influence the moisture deposits significantly. This opinion is supported by M.I. Cheriachukin, L.P. Dziuba [13] and other researchers [14].

In the conditions of insufficient and unstable humidification the soil tillage is supposed to ensure favorable water regime in crop rotations during the whole period of crop vegetation and in the period of the most intensive water consumption by plants. Thus, sugar beets' greatest need for moisture is observed during the phase of leaves closure in row spacing which coincides with the maximum plants growth and sugar accumulation [15]. Maize is very sensitive to moisture deficiency and moisture stress in the period of 10-14 days before panicle emergence and grain milky ripeness. It lasts for about 30 days and is caused by the increased moisture consumption by the plants [16]. The period from stem elongation to ear emergence is a critical period when the barley plants are the most moisture stress sensitive [17].

The difference in opinions concerning the researches conducted by scholars in different regions of our country encouraged us to study the influence of different ways of soil tillage on moisture supply for sugar beet plants, spring barley and maize.

Methodology of the research. The issue of moisture supply of sugar beets, spring barley and grain maize was studied on the black podzolized soil of the experimental field of the education-scientific-production department of Uman National University of Horticulture during the period of 2005–2008 in the permanent field experiment with different variants of primary soil tillage in five-field crop rotation with such crops grown: 1 – peas, 2 – winter wheat, 3 – sugar beets, 4 – spring barley, 5 – grain maize.

The experiment scheme included the following variants:

1 – moldboard plowing under all the crops: peas, winter wheat and spring barley – 20–22 cm; under maize – 25–27 cm; under sugar beets – 30–32 cm (control);

2 – 6–8 см cultivation under all the crops;

3 – 6–8 cm cultivation under most crops except sugar beets where 30–32 cm plowing was carried out;

4 – no-tillage under most crops except sugar beets where 30–32 cm plowing was carried out.

Moldboard plowing was carried out with the PLN–4–35 plow, and cultivation – with the KPE–3,8 cultivator. Different variants were placed according to the method of randomized repetitions. The experiment variants were repeated three times. The plots area was 576 m^2. Deposits of moisture in 0–160 cm soil layer were estimated by means of thermostatic-weighing method basing on the data regarding soil moisture during the sowing period, middle of the vegetation period and before harvesting sugar beets, spring barley and grain maize.

The research results. The amount of atmospheric precipitation, which is the main source of moisture in natural conditions, is one of the factors influencing the formation of moisture deposits in the soil. The deposits of moisture, which are formed in the soil due to primary tillage in autumn before sowing spring crops, are mainly influenced by the amount of precipitation during autumn-winter-early spring period. Thus, the average many-year amount of atmospheric precipitation during this period is 297 mm while in 2004-2005 agricultural year it was 335,4 mm, in 2005/2006 – 302,6, in 2006/2007 – 210,4 and in 2007/2008 – 216,7mm. On this basis it possible to make a conclusion that only in 2004/2005 and 2005/2006 agricultural years the general amount of precipitation in autumn-winter-early spring period facilitated the formation of sufficient amount of moisture in the soil before spring field work.

The data of table 1 demonstrate how the conditions of supplying sugar beet plants with available water were formed depending on different ways of primary soil tillage. As it is seen, in the average during 2005–2008, by the time of the crops sowing the tendency to reduction of spring deposits of available moisture was observed after changing the 30–32 cm plowing by 6–8cm cultivation. Thus, in 0–30 cm soil layer the difference was within 2,7–3,7 mm and in the layers of 0–100 cm and 0–160 cm it grew to 4,2–7,2 and 5,4–9,0 correspondingly. In our opinion the increase of deposits of moisture in the soil after plowing can be explained by greater

1. Deposits of available moisture in the areas under sugar beets after different variants of soil tillage, mm (average for 2005–2008)

Experiment variants*	Sowing time			Leaves closure in row spacing			Before harvesting		
	Soil layer, см								
	0–30	0–100	0–160	0–30	0–100	0–160	0–30	0–100	0–160
1.	51,4	170,6	252,9	27,3	103,7	165,9	25,0	73,2	104,3
2.	48,7	166,4	247,5	29,5	111,0	174,1	27,1	80,4	114,7
3.	52,1	173,0	255,8	27,5	105,7	167,6	24,8	74,6	106,4
4.	52,4	173,6	256,5	27,7	105,4	168,7	25,1	75,5	106,8

* – variants according to the experiment scheme

soil porosity after such soil treatment which led to higher water-transmitting capacity.

By the period of the leaves closure in row spacing the deposits of available water during the whole experimental period reduced as compared to the initial level by 1,8, 1,6 and 1,5 times in 30, 100, and 160-cm soil layers correspondingly. As to the influence of the researched factor on the moisture supply of sugar beets during this period, it should be admitted that the dependence has changed in comparison with the sowing period. In the period of leaves closure the tendency to increase the deposits of available moisture in the soil was observed after 6–8 cm cultivation relative to variants where 30–32 cm. moldboard plowing was carried out, which comprised 1,8–2,2, 5,3–7,3 and 5,4–8,2 mm correspondingly in the soil layers of 0–30, 0–100 and 0–160cm. In our opinion, the reduction of the deposits of moisture in the soil in this period in the plowing variants can be explained by the increase of its nonproductive expenditure because of evaporation from the soil surface due to its looser structure in the plow layer.

By the end of the vegetation period the deposits of available water in the soil continued to reduce in all experiment variants in comparison with the period of leaves closure. Before harvesting sugar beet roots, the deposits of available moisture in the soil after cultivation remained a little higher and exceeded the moisture deposits in the variants where 2,0–2,3, 4,9–7,2 and 7,9–10,4 mm plowing was carried out in the soil layers of 0–30, 0–100 and 0–160 cm correspondingly.

The formation of the conditions for supply of spring barley with available moisture depending on the variants of primary soil tillage can be seen from the analysis of the data of table 2. It shows that in the average during 2005–2008 in the period of sowing crops the deposits of available moisture after moldboard plowing in the soil layers 0–30, 0–100 and 0–160 cm were 52,5, 160,9 and 232,2 mm. After cultivation and no-tillage some reduction of spring deposits of moisture was noticed which comprised in these layers 1,5–1,9, 2,3–2,8, 2,8–3,6 and 3,2, 4,6, 6,1 mm correspondingly.

By the time of the spring barley's ear formation the deposits of available moisture generally decreased in comparison with the spring deposits by 2,1, 1,9 1,7 times correspondingly in plow, meter and 160-cm soil layers.

As for the influence of variants of primary soil tillage on supply of spring barley plants with moisture before the period of ear formation it should be admitted that a clear tendency to increase deposits of available moisture in all soil layers after minimization of primary tillage relative to the conventional one was observed.

2. Deposits of available moisture in the areas under spring barley after different variants of primary soil tillage, mm (average during 2005–2008)

Experiment variants*	Sowing time			Beginning of ear formation			Before harvesting		
	Soil layer, см								
	0–30	0–100	0–160	0–30	0–100	0–160	0–30	0–100	0–160
1.	52,5	160,9	232,2	22,5	79,7	130,4	13,4	50,7	89,8
2.	50,6	158,6	229,4	24,1	84,8	136,6	15,1	55,5	96,0
3.	51,0	158,1	228,6	23,9	83,9	135,9	14,9	54,7	94,6
4.	49,3	156,3	226,1	24,7	85,0	137,0	15,5	55,8	96,9

***–** variants according to the experiment scheme

By the end of vegetation period of spring barley the deposits of moisture in the soil continued to reduce compared to the period of ear formation in all experiment variants. Before harvesting the spring barley the deposits of moisture in all soil layers after minimal tillage and in the average during the four years exceeded the deposits of moisture after 1,5–2,2, 4,0–5,1 and 4,8–7,1 mm plowing correspondingly in the soil layers of 0–30, 0–100 and 0–160 cm.

The research results, shown in table 3, prove that in the average, during 2005–2008 at the time of sowing maize after changing moldboard plowing for cultivations and in the variant without primary tillage the reduction of moisture amounts in the plow soil layer by 1,3–1,4 and 2,1 mm was observed and in meter and 160-cm soil layers it was 3,8–4,9 and 6,1mm and 3,6–5,4 and 7,3 mm correspondingly.

By the beginning of panicle emergence of maize, the deposits of available water in the soil during the whole experiment reduced by 1,6–1,9 times in comparison with the initial period. As to the influence of primary soil tillage on the moisture content, the dependence between these indices has changed relative to the period of the crop sowing, when plowing prevailed. In this period a clear tendency was noticed to increase the deposits of available moisture in the soil profile after minimal soil treatment relative to plowing with the biggest difference in 160-cm layer which was within limits of 5,5–10,2 mm.

From the middle till the end of the vegetation period of maize the moisture deposits in the soil layers of 0–100 and 0–160 cm reduced while in the upper 30-cm layer it, on the contrary, somewhat increased. The dependence between the variants

3. Deposits available moisture in the areas under maize after different variants of primary soil tillage, mm (average during 2005–2008)

Experiment variants*	Sowing time			Panicle emergence			Before harvesting		
	Soil layer, см								
	0–30	0–100	0–160	0–30	0–100	0–160	0–30	0–100	0–160
1.	49,3	165,6	240,3	24,6	86,8	140,3	25,2	76,9	121,2
2.	47,9	161,8	236,7	26,0	90,7	148,0	27,1	83,0	131,5
3.	48,0	160,7	234,9	25,7	89,6	145,8	26,8	81,1	128,5
4.	47,2	159,5	233,0	26,5	91,9	150,5	27,7	84,7	133,9

***–** variants according to the experiment scheme

of soil tillage and deposits of available moisture, observed during the period of maize panicle emergence, remained the same till the period of harvesting the crop where cultivation and no-tillage prevailed comprising 7,3–12,7 mm in the 0–160 cm soil layer.

Conclusion. Different variants of primary soil tillage in crop rotation influenced insignificantly on the amounts of moisture in the soil during the vegetation period of sugar beets, spring barley and maize, in particular, during the sowing time the deposits of available moisture were slightly bigger after plowing and by the middle of vegetation and before harvesting the same was observed after cultivation and without primary soil tillage.

REFERENCES

1. Коломієць М.В. Урожайність ячменю при різних способах обробітку ґрунту / М.В. Коломієць // Вісник сільськогосподарської науки. — 1980. — №8. — С. 21–24.
2. Логачев Ю.Б. Обработка почвы под сахарную свеклу / Ю.Б. Логачев // Достижения науки и техники АПК. — 1992. — №5. — С. 16–17.
3. Тимошенко С.М., Вербицький В.В. / С.М. Тимошенко, В.В. Вербицький // Енергозберігаючий обробіток ґрунту. — Цукрові буряки. — 1998. — №2. — С. 12–13.
4. Жолинский Н.М. Почвозащитные приемы при возделывании яровой пшеницы / Н.М. Жолинский // Земледелие. — 2004. — №6. — С. 13–14.
5. Плодородие почвы и продуктивность полевого севооборота в зависимости от систем основной обработки ее в Лесостепи УССР / А.Г.Яворский, Ю.П. Манько, И.П. Максимчук [и др.] // Земледелие. — Вып. 64. — 1989. — С. 21–26.
6. Бука А.Я. Влагообеспеченость почвы при различных способах обработки / А.Я. Бука, С.Ю. Булыгин, А.П. Коваленко // Земледелие. — 1985. — №11. — С. 10–12.
7. Танчик С.П. Вплив систем обробітку на водно-фізичні властивості ґрунту і продуктивність кукурудзи на зерно в Лісостепу України / С.П. Танчик, С.В.Басанець // Науковий вісник Національного аграрного університету. — К., 2006. — Вип. 100. — С. 52–56.
8. Шептухов В.Н. Особенности возделывания культур при минимализации
9. обработки суглинистой почвы / В.Н.Шептухов, М.М. Галкина, А.Ф. Нестерова // Земледелие. — 1995. — №5. — С. 18–20.
10. Яковлев В.Х. Высокий урожай без осенней обработки / В.Х. Яковлев // Земледелие. — 2001. — №5. — С. 33.
11. Круть В.М. Обработка полей при возделывании ячменя / В.М. Круть, Н.Ф. Бенедичук // Зерновое хозяйство. — 1981. — №4. — С. 37–38.
12. Продуктивність ярого ячменю на південному сході Степу України / Є.М.Лебідь, В.О. Білогуров, О.М. Суворінов, З.Д. Місюра // Вісник аграрної науки. — 1991. — №1. — С. 25–26.
13. Бомба М.Я. Комплексное действие обработки, удобрений и гербицидов на
14. продуктивность кукурузы / М.Я. Бомба, М.И. Бомба // Кукуруза и сорго. — 2000.

– №4. — С. 7–8.

15. Черячукін М.І. Ефективність альтернативного землеробства у північному Степу України / М.І. Черячукін, Л.П. Дзюба // Аграрний вісник Причорномор'я. — Одеса, 1999. — Частина І: Агрономія. — №3(6). — С. 55–61.
16. Вчасно провести основний обробіток ґрунту / І.С. Шкаредний, О.М. Хильницький, В.П. Юрчак [та ін.] // Цукрові буряки. — 2000. — №5. — С. 12–13.
17. Буряківництво. Проблеми інтенсифікації та ресурсозбереження / За ред. В.Ф. Зубенка. — Київ: НВП ТОВ „Альфа-стевія ЛТД”, 2007. — 488 с.
18. Циков В.С. Особливості технології вирощування кукурудзи в умовах недостатнього й нестійкого зволоження степової зони України / В.С. Циков // Пропозиція. — 2000. — №4. — С. 39–41.
19. Борисонік З.Б. Ярі колосові культури / З.Б. Борисонік. — К.: Урожай, 1975. — 176 с.

Одержано 15.03.13

O.S. Kozubenko, P.V. Kostohryz. Moisture supply of sugar beet plants, spring barley and maize under different primary tillage in crop rotation

Soil tillage has to facilitate the improvement of water accumulation, rational utilization of moisture by plants and prevention of its nonproductive waste due to evaporation. The main task of the research was to study the influence of different variants of primary tillage in five-field crop rotation on supply of sugar beet plants, spring barley and maize with moisture. Deposits of moisture in the soil layer 0–160 cm were estimated by means of thermostatic-weighing method basing on the data regarding soil moisture during the sowing period, middle of the vegetation period and before harvesting sugar beets, spring barley and grain maize, the research results demonstrated that different variants of primary soil tillage in crop rotation influence insignificantly on the amount of moisture during the vegetation period. Thus, by the time of sowing sugar beets, spring barley and maize somewhat bigger deposits of moisture were observed after moldboard plowing under these crops correspondingly by 30–32, 20–22 and 25–27 cm and by the middle of growth and before harvesting it happened on the contrary after 6–8 cm cultivation and in the no-tillage variant.

Key words: *primary tillage, deposits of available moisture, sugar beets, spring barley, maize.*

О.С. Козубенко, П.В. Костогриз. Влагообеспеченность растений свеклы сахарной, ячменя ярового и кукурузы при различной основной обработке почвы в севообороте.

Обработка почвы в первую очередь должна способствовать влагонакоплению, рациональному использованию влаги растениями и

предупреждению непродуктивных ее потерь вследствие испарения. Задачей наших исследований было изучение влияния различных вариантов основной обработки почвы в пятипольном севообороте на влагообеспеченность растений свеклы сахарной, ячменя ярового и кукурузы. Запасы доступной влаги рассчитывали в слое почвы 0 – 160 см термостатно-весовым методом на основе влажности почвы на время сева, средину вегетации и перед уборкой урожая свеклы сахарной, ячменя ярового и кукурузы. Результатами исследований установлено, что различные варианты основной обработки почвы в севообороте мало влияют на количество влаги в ней в течение вегетации культур. Так, на время сева свеклы сахарной, ячменя ярового и кукурузы несколько большие ее доступные запасы были после отвальной вспашки под эти культуры соответственно на 30 – 32, 20 – 22 и 25 – 27 см, а на средину вегетации и перед уборкой урожая, наоборот — на фоне культивации на 6 – 8 см и в варианте без основной обработки почвы.

Ключевые слова: *основная обработка почвы, запасы доступной влаги, свекла сахарная, ячмень яровой, кукуруза.*