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GRANULALASH JARAYONIDA TEXNOLOGIK PARAMETRLARNING GRANULA SIFATIGA TA'SIRI

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Annotatsiya. Ushbu maqolada granulalash qurilmasining turli parametrlariga bog'liq holda tayyorlangan granulaning sifati tahlil qilingan. Tajribalar davomida roliklarning aylanish soni, roliklar soni, pichoqning o'rnatilish burchagi va preslash kamerasi balandligining granulalarning uzunligi va uvalanish darajasiga ta'siri o'rganildi. Natijalar shuni ko'rsatdiki, har bir parametrning optimal qiymati mavjud bo'lib, u granulalarning sifat darajasini oshirishga yordam beradi.

Tayanch so'zlar: Granulalash, texnologik parametrlar, granulalarning sifati, rolikning aylanish soni, pichoqning burchagi, preslash kamerasi balandligi, granulalarning bir xilligi, uvalanish darajasi.

ВЛИЯНИЕ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ НА КАЧЕСТВО ГРАНУЛ ПРИ ПРОЦЕССЕ ГРАНУЛИРОВАНИЯ

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Аннотация. В данной статье анализируется качество гранул, подготовленных в зависимости от различных параметров гранулирующего устройства. В ходе экспериментов изучалось влияние скорости вращения роликов, количества роликов, угла установки ножа и высоты прессовочной камеры на однородность длины и степень разрушения гранул. Результаты показали, что существует оптимальное значение каждого параметра, которое способствует повышению качества гранул.

Ключевые слова: Гранулирование, технологические параметры, качество гранул, скорость вращения роликов, угол ножа, высота прессовочной камеры, однородность гранул, степень разрушения.

INFLUENCE OF TECHNOLOGICAL PARAMETERS ON GRANULE QUALITY IN THE GRANULATION PROCESS

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Annotation. This article analyzes the quality of granules prepared depending on various parameters of the granulation device. During the experiments, the influence of roller rotation speed, the number of rollers, the knife installation angle, and the height of the pressing chamber on the uniformity of granule length and the degree of crumbling was studied. The results showed that each parameter has an optimal value that helps improve the quality of the granules.

Keywords: Granulation, technological parameters, granule quality, roller rotation speed, knife angle, pressing chamber height, granule uniformity, crumbling degree.

Kirish. Granulalash jarayoni qishloq xo‘jaligi, ozuqaviy sanoat va boshqa ko‘plab sohalarda muhim ahamiyat kasb etadi. Ushbu jarayonda texnologik parametrlarning to‘g‘ri tanlanishi granulaning sifati va samaradorligiga ta’sir ko‘rsatadi. Granulalarning uzunligi bo‘yicha bir xilligi va uvalanish darajasi mahsulot sifatini belgilovchi muhim omillardan biri hisoblanadi. Shu sababli, ushbu maqolada granulalash jarayonida muhim bo‘lgan texnologik parametrlarning ta’siri tadqiq etildi.

Granulalash jarayoni oziq-ovqat va ozuqabop mahsulotlar ishlab chiqarishning ajralmas qismi bo‘lib, ayniqsa chorvachilikda yem tayyorlashda keng qo‘llaniladi. Zamonaviy texnologiyalar yordamida ozuqaning fizik va mexanik xususiyatlarini yaxshilash, mahsulotning saqlash muddatini uzaytirish va oziqaviy qiymatini oshirish mumkin. Granulalarning sifati ularning shakli, mustahkamligi, bir xilligi va yemishliligi bilan bog‘liq bo‘lib, bu parametrlar ishlab chiqarish samaradorligi va hayvonlarning oziqlanish darajasiga ta’sir ko‘rsatadi.

Shuningdek, granulalash uskunalarining texnik sozlamalari mahsulot sifatiga bevosita ta’sir qiladi. Masalan, roliklarning aylanish tezligi, ularning soni, pichoqlarning joylashish burchagi va preslash kamerasining balandligi granulaning tuzilishi va mustahkamligini belgilaydi. Ushbu tadqiqotning maqsadi ana shu parametrlarning optimal qiymatlarini aniqlash va ularning granula sifatiga ta’sirini o‘rganishdan iboratdir.

Bundan tashqari, ilgari o'tkazilgan tadqiqotlar va ilmiy adabiyotlar ham ushbu mavzuga oid qimmatli ma’lumotlarni taqdim etgan bo‘lib, ularning natijalari bizning tadqiqotimizga asos bo‘ldi. Ushbu maqolada granulalash jarayonini ilmiy asosda tahlil qilish va natijalarga ko‘ra eng samarali texnologik parametrlarni aniqlash ko‘zda tutilgan.

Metodologiya. Tadqiqot laboratoriya sharoitida maxsus granulalash qurilmasida olib borildi. Granulalash jarayonida ishlatilgan asosiy material tarkibiga ozuqaviy komponentlar va bog‘lovchi moddalar kiritildi. Tadqiqot davomida granulalash qurilmasining quyidagi parametrlariga e’tibor qaratildi:

1. Rolikning aylanishlar soni (ayl/min) – 325, 350, 375, 400
2. Roliklar soni (dona) – 1, 2, 3
3. Pichoqning o‘rnatilish burchagi (gradus) – 160, 170, 180, 190
4. Preslash kamerasi balandligi (mm) – 6, 8, 10, 12

Tadqiqot jarayonida namunalar har bir parametr bo‘yicha tayyorlanib, ularning fizik-mexanik xususiyatlari tahlil qilindi. Olingan natijalar granulalarning uzunligi bo‘yicha bir xilligi (%) va uvalanishi (%) ko‘rsatkichlari asosida baholandi. Har bir tajriba uch marta takrorlanib, o‘rtacha qiymatlar hisoblab chiqildi.

Natijalar.

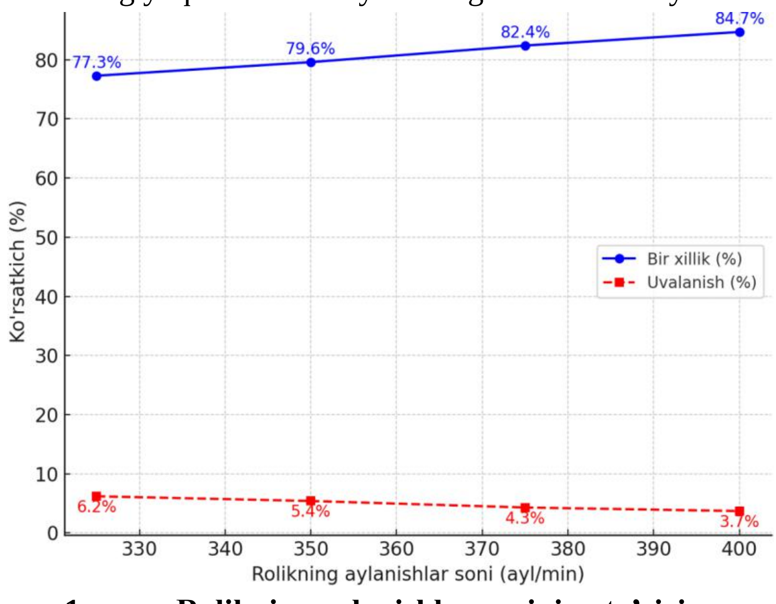
Rolikning aylanishlar soning ta'siri. Rolikning aylanishlar soni ortgan sari granulalarning uzunligi bo'yicha bir xillik oshdi (77,3% dan 84,7% gacha). Shu bilan birga, uvalanish darajasi kamaydi (6,2% dan 3,7% gacha). Bu esa rolikning aylanishlar sonining optimal diapazonda bo'lishi granulalarning sifati uchun muhim ekanligini ko'rsatadi. Ayniqsa, 375–400 ayl/min oralig'ida granulalarning bir xilligi sezilarli darajada ortib, uvalanish kamaygan. Bu esa yuqori tezlikda ishlash granulalarning mustahkamligini oshirishini isbotlaydi.

Roliklar soning ta'siri. Roliklar soni ortishi granulalarning bir xillik darajasini yaxshiladi. Bunda bir xillik 78,6% dan 84,1% gacha oshdi. Shu bilan birga, uvalanish kamaydi (5,3% dan 3,6% gacha). 2 va 3 ta rolik o'rtasida sezilarli farq kuzatilgan bo'lib, 3 ta rolik ishlatilganda granulaning sifati optimal darajaga yetdi. Bu esa ko'proq roliklardan foydalanish granulalash sifatini oshirishi va ishlab chiqarish samaradorligini oshirishini ko'rsatadi.

Pichoqning o'rnatilish burchagining ta'siri. Pichoq burchagi oshganda, granulalarning uzunligi bo'yicha bir xillik 78,3% dan 82,9% gacha o'sdi. Biroq, uvalanish darajasi 6,2% dan 4,1% gacha kamayib, keyinchalik 5,9% ga qayta oshgan. Bu esa pichoqning o'rnatilish burchagini optimal tanlash muhimligini ko'rsatadi. 180 graduslik burchak eng yaxshi natijalarni ko'rsatgan bo'lib, undan kattaroq burchakda uvalanish ortishi kuzatilgan. Bu esa kesish jarayonining o'ziga xos mexanik xususiyatlari bilan bog'liq bo'lishi mumkin.

Preslash kamerasi balandligining ta'siri. Preslash kamerasi balandligi oshishi natijasida granulalarning bir xillik ko'rsatkichi 77,4% dan 82,5% gacha ortib, keyin 79,1% ga pasaygan. Uvalanish darajasi esa 6,5% dan 4,6% gacha kamayib, keyin 6,8% ga oshgan. Bu esa balandlikning optimal diapazonda bo'lishi lozimligini ko'rsatadi. Ayniqsa, 10 mm balandlik eng yaxshi natijalarga olib kelgan bo'lib, 12 mm da uvalanish ortib ketgan. Bu esa juda baland kameraning granulani siqish darajasini pasaytirib, ularning mustahkamligini kamaytirishini ko'rsatadi.

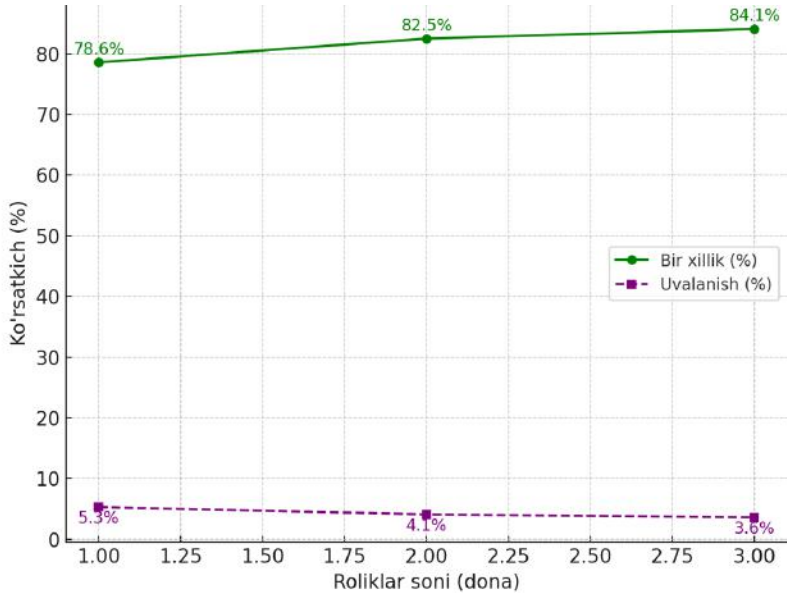
Rolikning aylanishlar soni oshgani sari granulalarning uzunligi bo'yicha bir xilligi sezilarli darajada ortganini ko'rish mumkin. Masalan, 325 ayl/min da bir xillik 77,3% bo'lgan bo'lsa, 400 ayl/min da bu ko'rsatkich 84,7% ga yetgan. Aksincha, uvalanish darajasi 6,2% dan 3,7% gacha kamaydi. Bu holat, roliklarning yuqori tezlikda aylanishi granula sifatini yaxshilashini anglatadi.



1-rasm. Rolikning aylanishlar soning ta'siri

Roliklar soning ortishi ham granula sifatiga ijobiy ta'sir ko'rsatadi. 1 ta rolik bilan bir xillik 78,6% bo'lganida, 3 ta rolikda bu ko'rsatkich 84,1% ga yetgan. Shuningdek, uvalanish darajasi 5,3% dan

3,6% gacha kamaygan. Demak, ko'proq roliklardan foydalanish granula bir xilligini oshirib, uvalanishni kamaytiradi.



2-rasm. Roliklar sonining ta'siri

Xulosa. Tadqiqot natijalari shuni ko'rsatdiki, granulalash jarayonining texnologik parametrlarini to'g'ri tanlash orqali granulaning sifati sezilarli darajada yaxshilanishi mumkin. Rolikning aylanishlar sonini 400 ayl/min gacha oshirish, roliklar sonini 3 taga yetkazish, pichoqning o'rnatilish burchagini 180 gradusda ushlash va preslash kamerasi balandligini 10 mm atrofida saqlash eng yaxshi natijalarga olib kelishi mumkin. Ushbu parametrlarni optimallashtirish orqali granulalarning uzunligi bo'yicha bir xilligi oshirilib, uvalanish darajasi kamaytirilishi mumkin.

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МОДЕРНИЗАЦИЯЛАШТИРИЛГАН РОТОРЛИ – РОЛИКЛИ НАСОСНИНГ БОСИМ ВА ЭНЕРГЕТИК КЎРСАТКИЧЛАРИ

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Аннотация. Мақолада модернизацияланган ПГМ–38М русумли роторли-роликли насосларни синаш натижалари хамда улардан замонавий ўсимликларни кимёвий химоялаш машиналари тизимида фойдаланиш истиқболлари ёритилган.

Калит сўзлар: роторли-роликли насос, ишчи босим, кувват, ФИК.

ДАВЛЕНИЕ И ЭНЕРГЕТИЧЕСКИЕ ПОКАЗАТЕЛИ МОДЕРНИЗИРОВАННОГО РОТОРНО-РОЛИКОВОГО НАСОСА

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Аннотация. В статье приводится анализ результатов испытаний модернизированного роторно-роликового насоса ПГМ–38М и перспектива их использования в системе машин для химической защиты растений.

Ключевые слова: роторно-роликовый насос, рабочее давление, мощность, КПД.

PRESSURE AND ENERGY PERFORMANCE OF A MODERNIZED ROTARY ROLLER PUMP

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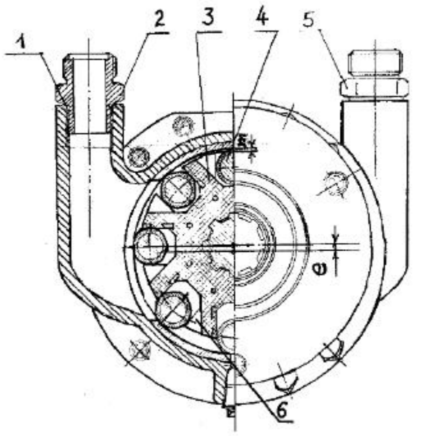
Abstract. The article provides an analysis of the test results of the modernized rotary-roller pump PGM-38M and the prospects for their use in the system of machines for chemical plant protection.

Key words: rotary-roller pump, working pressure, power, efficiency.

Кириш. Қишлоқ хўжалик экинларини кимёвий ҳимоялаш жараёнида фойдаланилаётган ишси суюқликларнинг самарадорлигини ошириш, энергия ва ашё ресурсини тежовчи янги пуркаш машиналарини яратишни, камхажмли юқоридисперсли пуркаш технологияларини агросаноат мажмуаси (АСМ) га кенг жорий қилишни тақазо этмокда [1-4].

Материаллар ва услублар. Янги юқоридисперсли пуркаш технологиясига ўтишда анъанавий пуркаш машиналари таркибидаги роторли-роликли насос (РРН) конструкцияси тизимини хам такомиллаштиришни талаб қилади. Республикамиз АСМ да серияли ишлаб чиқарилаётган ОШХ-600 русумли штангали ва ОВХ-600 русумли вентиляторли пуркагичлари асосан роторли – роликли насослар билан жихозланган. Роторли – роликли насосларда энг кўп ейилиш турлари – бу роликлардаги полимер қопламларнинг шишиши, роликларнинг бочкасимон ейилиши, роликлар ҳаракатланадиган арикча ишчи сиртларининг ейилиши ва бошқалардир.

Модернизациялаштирилган роторли-роликли насоснинг таркибий элементлари 1-расмда келтирилган.



1-расм. Модернизациялаштирилган ПГМ – 38М роторли-роликли насоснинг таркибий элементлари:
1-корпус; 2,5- киритиш ва чиқариш найчалари;
3- ротор; 4- ролик; 6-. ролик арикчаси;
е-эксцентриситет.

Модернизациялаштирилган роторли-роликли насос қуйидаги тартибда ишлайди. Ротор 3 айланма ҳаракатланиш вақтида роликлар 4 ротор билан корпус оралиғида “m” га тенг бўлган тирқишни тўсишга интилади. Ролик арикчалари 6 бўшлиғига тушган ишчи суюқлик ҳажмини суриш жойидан сиқиб чиқариш жойига кетма-кет тарзда элтиб беради. Ҳосил бўлган ишчи суюқлик сарфи агрегатнинг гидравлик коммуникациясида ишчи босими P ни насоснинг унумдорлиги Q, қуввати N, ФИК η ларини ҳосил қилади. Уларнинг мақбул қийматлари насоснинг $в_у$, $б_m$, $h_у$, n, p параметрларига боғлик [2].

Натижалар ва уларнинг муҳокамаси. Тадқиқотларнинг кўрсатишича [5-7] роторли – роликли насосларда ишчи суюқликни узатиш барқарорлиги улар таркибидаги роликларнинг оғирлигига (G=mg), ротор пазаларининг кенглигига ($в_р$), чекка зичлагичларини сиқиш даражасига (2 h= $B_{ру}$ - $B_к$) ҳам боғлиқлиги маълум бўлди. Экспериментал роторли–роликли насосларга (РРН) оид тадқиқод натижалари 2- а,б,в,г расмларда тақдим этилган.

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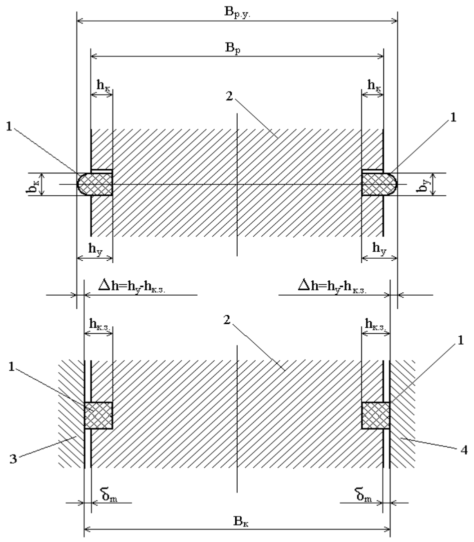

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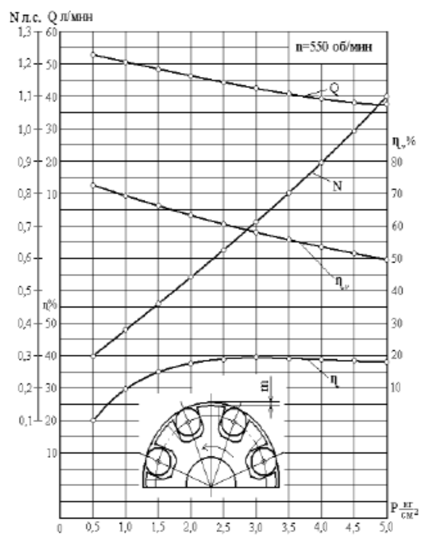
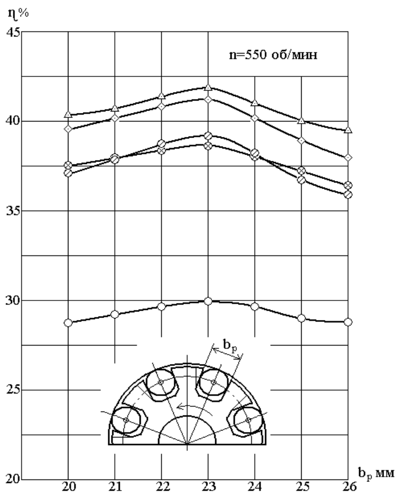


в)



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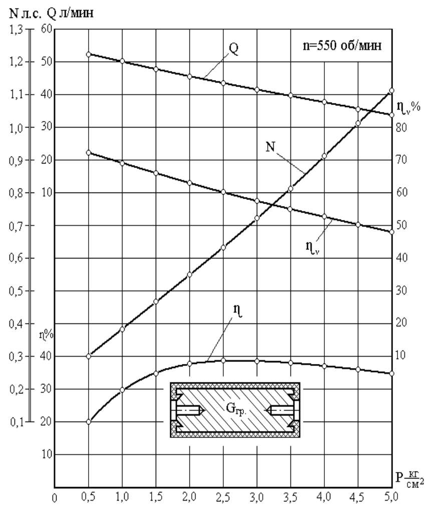

2-расм. РРН ларга ўрнатилган зичлагичларнинг таранглигини аниқлаш схемаси

(а): 1-ротор, 2-зичлагич, 3,4-корпус; б- радиал тирқиш m=0,15 мм ли РРН нинг босим ва энергетик характеристикаси; в- ротор арикчалари кенглиги $b_р$ га боғлиқ равишда РРН нинг ФИК η нинг ўзгариши: при P=1 кг/см^2; при P=2 кг/см^2; при P=3 кг/см^2; при P=4 кг/см^2; при P=5 кг/см^2; г- ролик оғирлиги G=50 гр га тенг бўлгандаги РРН нинг босим ва энергетик характеристикаси.

Уларнинг таҳлили қуйидаги муҳим хулосалар қилишга имкон берди:

- ишчи суюқлик босими 1 – 5 кг/см оралиғида зичлагичларнинг оптимал суюқлик 2h қиймати 0,1 – 1,0 мм га тенглигини;.
- роторли – роликли насоснинг мақбул унумдорлигини таъминлашда хар хил босимлар учун ротор пази кенглиги Вр = 23 мм энг мақбуллигини;
- насоснинг фойдали иш коэффиценти η, ролик оғирлиги 50 – 60 гр энг мақбуллигини;
- оғирлашган роликлардан фойдаланиш, насос таркибидаги гильзалар билан роликларнинг жадал ейилишига, уларнинг тез шишишига олиб келишини;
- насос корпусининг цилиндрик ишчи сирти оралиғидаги мақбул радиал тирқиш m=0,15 - 0,2 мм га тенг бўлди. Бу тирқиш, босим 3,5 кг/см учун 0,10 мм, 4 кг/см учун 0,05 мм га тенглигини;
- роликлар сони 8 – га ва уларнинг оғирлиги эса 50 гр етганда РРН нинг фойдали иш коэффициенти (ФИК) η энг баланд бўлишини кўрсатди.

Модернизациялаштирилган роторли-роликли насослар (ПГМ – 38М) нинг хорижий фирмаларида ишлаб чиқарилаётган маркаларига нисбатан таққослаш кўрсаткичлари 1–жадвалда кўрсатилган.

1 – жадвал

Роторли – роликли насосларини таққослаш кўрсаткичлари

Насос маркаси	Давлат	Техник – иқтисодий кўрсаткичлари									
		Эркин сепиш пайтида			P = 3,5 кг/см			P = 5 кг/см			Масса-си, Н
		Q, л/мин	N о.к	ФИК n	Q, л/мин	N о.к	ФИК n	Q, л/мин	N о.к	ФИК n	
ПГМ – 38М	Ўзбекис-тон	58,0	0,25	–	49,0	0,75	0,51	47,0	1,25	0,48	95
ПГМ–38 сериявий	Ўзбекис-тон	56,0	0,42	–	38,0	1,08	0,28	32,0	1,38	0,23	100
7150	АКШ	56,8	0,25	–	48,4	0,75	0,50	43,1	1,25	0,38	–
57 К	Швеция	55,0	0,35	–	–	–	–	45,0	0,75	0,6	75

Хулоса. Келажакда камҳажмли, юқори дисперсли кавиацион пуркаш технологиясига ўтишда модернизациялаштирилган роторли-роликли насослардан фойдаланишни тавсия этамиз. Кавиацион усулда пуркаш технологиясига ўтиш энергитик ва ашёлар ресурсини тежашга, барча пуркаш машиналари учун анча енгиллаштирилган ягона конструкцияга эга бўлган роторли – роликли насосга ўтишга имкон беради.

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UZUMNING TURLI NAVLARIDAN KUPAJ SHARBATI TAYYORLASH

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“Toshkent irrigatsiya va qishloq xo‘jaligini mexanizatsiyalash muhandislari instituti”
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Annotatsiya: Maqolada uzumning turli navlaridan kupaj sharbati olishning avfzalligi va vitaminlarga boyligi haqida ma‘lumotlar keltirib o‘tilgan. Ta‘mning uyg‘unligi – bir nechta navlarning aralashuvi sharbatini boy va murakkab ta‘mga ega ekanligi. Rang va aromat – turli navlar aralashuvi tabiiy rang va yoqimli hid hosil qiladi. Sog‘liq uchun foydali kupaj sharbati turli xil uzum navlarining foydali moddalarini o‘zida mujassam qiladi. Uzum tarkibidagi shakarlar energiya manbai bo‘lib xizmat qiladi. Antioksidantlar hujayralarni erkin radikallardan himoya qiladi. Tarkibidagi tolalar hazm qilish tizimini yaxshilaydi.

Kalit so‘zlar: kupaj, sharbat, inspeksiyalash, qizdirish, texnologik, gomogenizatsiyalash, etiketkalash.

КУПАЖНЫЙ СОК ИЗ РАЗНЫХ СОРТОВ ВИНОГРАДА ПОДГОТОВКА

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Аннотация: В статье представлена информация о преимуществах получения сока из разных сортов винограда и богатстве витаминов. Гармония вкуса – сочетание нескольких сортов придает соку насыщенный и сложный вкус. Цвет и аромат – смесь разных сортов создает натуральный цвет и приятный аромат. Полезный купажный сок содержит полезные вещества различных сортов винограда. Сахара в винограде служат источником энергии. Антиоксиданты защищают клетки от свободных радикалов. Содержание клетчатки улучшает работу пищеварительной системы.

Ключевые слова: купаж, сок, контроль, нагрев, технологический, гомогенизация, маркировка.

COUPE JUICE FROM DIFFERENT VARIETIES OF GRAPES PREPARATION

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Abstract: The article provides information about the advantages of extracting juice from different varieties of grapes and the richness of vitamins. The harmony of taste - the combination of

several varieties gives the juice a rich and complex taste. Color and aroma - a mixture of different varieties creates a natural color and pleasant aroma. Healthy coupage juice contains the beneficial substances of various grape varieties. Sugars in grapes serve as a source of energy. Antioxidants protect cells from free radicals. The fiber content improves the digestive system.

Key words: coupage, juice, inspection, heating, technological, homogenization, labeling.

Kirish. Hozirgi kunda dunyo bo‘yicha tokzorlarning umumiy maydoni 7 mln. 546 ming gektarni, yalpi uzum hosili 62 mln. tonnani tashkil etmoqda. Yetishtiriladigan uzum hosilining asosiy qismi – 83% vino tayyorlash, 12% yangiligicha iste’mol qilish va 5% quritish (mayiz) uchun ishlatiladi. Dunyo bo‘yicha yetishtirilgan uzumning 31 mln. tonnasi Yevropa, 12,5 mln. tonnasi AQSh, 13,5 mln. tonnasi Osiyo, 3,1 mln. tonnasi Afrika va 3,1 mln. tonnasi Avstraliya va Yangi Zelandiya mamlakatlari ulushiga to‘g‘ri kelib, uzum hosildorligi o‘rtacha 82,2 s/ga ni tashkil etmoqda[10].

Respublikadagi barcha toifa xo‘jaliklari tasarrufida 113,3 ming gektar tokzorlar mavjud bo‘lib, shundan, 11,9 ming gektari sharobbop tokzorlar hisoblanadi. Hozirgi davrda respublikada tokzorlar maydonini ko‘paytirish, hosildorlikni va uzumni qayta ishlash quvvatini oshirish, jahon bozori talablariga javob beradigan mahsulotlarni yetishtirish kabi masalalarga katta e’tibor berilmoqda. Uzum tok o‘simligining mevasi bo‘lib, qadimda insoniyat tomonidan yetishtirib kelingan. Bu meva o‘zining ajoyib ta‘mi, shirinligi va foydali xususiyatlari bilan mashhur. Uzum yangi holatda ham quritilgan holatda ham iste‘mol qilinadi. Shuningdek, uzumdan sharbat, vino, sirka va boshqa mahsulotlar tayyorlanadi. Uzumning foydali xususiyatlari shundaki, vitamin va minerallarga boy bo‘lib, A, C, K, vitaminlari [6], B guruhidagi vitaminlar va kaliy, fosfor, temir kabi minerallar mavjud . Uzum tarkibidagi antioksidantlar hujayralarni zararlanishdan himoya qiladi va organizmni qarishdan saqlashda yordam beradi.

Materiallar va usullar.

Uzumning foydali xususiyatlari quyida keltirilgan: - uzumdagi resveratrol yurak-qon tomir kasalliklari xavfini kamaytiradi. Kaliy va magniy qon bosimini me‘yorda ushlab turadi. Polifenollar arteriya devorlarini elastik holatda saqlashga yordam beradi;

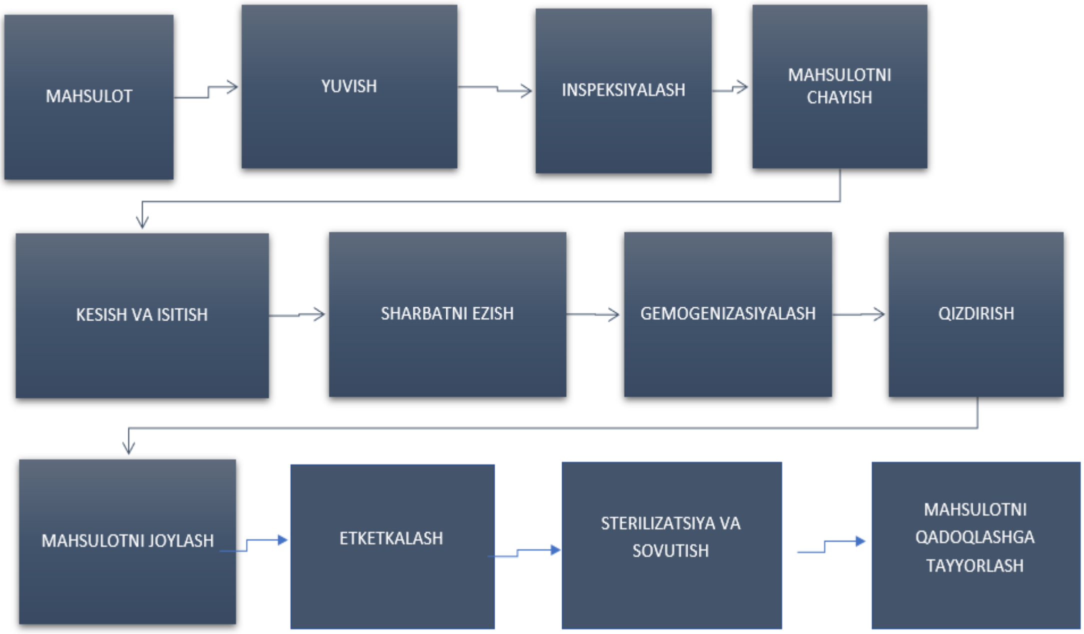
-immunitetni mustahkamlash, C vitamini va antioksidantlar organizmni infeksiyalardan himoya qiladi. Organizmning yallig‘lanishga qarshi faoliyatini kuchaytiradi;

- hazm qilish tizimi uchun uzum tarkibidagi tolalar ichak faoliyatini yaxshilaydi va toksinlarni chiqaradi. Organik kislotalar hazm jarayonini tezlashtiradi;

- miya faoliyatini yaxshilash resveratrol qonning miyaga oqimini oshirib, xotira va diqqatni kuchaytiradi. Polifenollar asab hujayralarini zararli ta’sirlardan himoya qiladi;

-teri va soch sog‘lig‘i uchun antioksidantlar teri qarishini sekinlashtiradi va organizmni yoshatiradi.

Bizda hozirgi kunda sharbat olishning mavjud texnologik jarayonini kurishimiz mumkin (1-rasm).



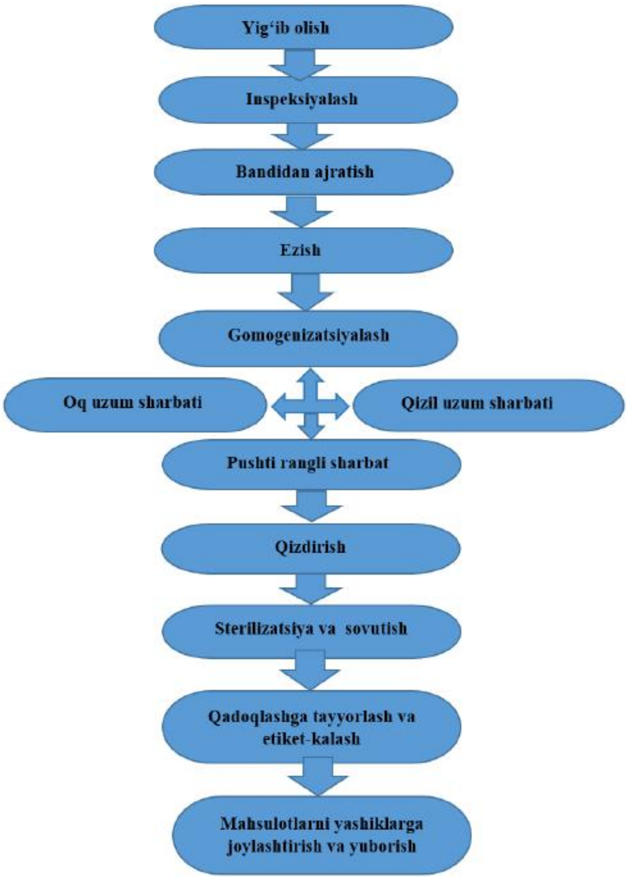
1-rasm. Meva va sabzavotlar hamda sitrus mevalaridan sharbat olish texnologik ketma-ketligi.

Natijalar va muhokam. Uzum yig‘ish vaqti uzum naviga, yetilish darajasiga va ob-havo sharoitlariga bog‘liq. Umuman olganda, O‘zbekistonda uzum terish mavsumi avgust oyi boshlarida boshlanadi va sentyabr oyi oxiriga qadar davom etadi. Ba‘zi kech pishadigan navlar uchun yig‘im-terim hatto oktyabr oyi boshiga ham cho‘zilishi mumkin. Yozning oxiri va kuzning boshi uzumning to‘liq yetilishiga imkon beradi, bu esa yaxshi ta‘m va shirinlikni ta‘minlaydi. To‘liq pishgan uzum o‘ziga xos shirin, shirador va aromatli bo‘ladi, terib olish vaqti esa shularni hisobga olgan holda tanlanadi. Bir vaqtning o‘zida va teng pishadigan uzum navlari asosan ertapishar, o‘rtapishar va kechpishar navlaridan iborat bo‘lib, ular odatda to‘liq yetilganda bir xil shirinlik va ta‘m hosil qiladi. [2]

Husayni va qora kishmish uzumlaridan tayyorlangan kupaj sharbati o‘ziga xos shirinlik va nordonlikni birlashtiradi, bu esa sharbatni yanada mazali qiladi. Har bir uzumning o‘ziga xos ta‘mi bor, shuning uchun bu navlarini birga aralashtirib, yaxshi natija olishmiz mumkin. Oq va qizil uzumning aralashmasidan pushti rangli mazali va vitaminlarga boy bo‘lgan sharbat tayyor bo‘ladi.

2-rasm. Husayni va qora kishmish navlari.

Biz taklif etayotgan Kupaj sharbati olish texnologiyasini quyidagi ketma-ketlikda ko‘rishingiz mumkin:



3-rasm. Kupaj sharbatining tayyorlash texnologiyasi.

Yuqorida keltirilgan texnologik ketma-ketligini olishda uzum sharbatini quyidagi rasmda keltirib o‘tilgan.

Oq uzum sharbati **Qizil uzum sharbati** **Oq va qizil uzumning kupaj sharbati**

4-rasm. Oq va qizil uzumning kupaj sharbati.

Bunday kupaj sharbati insonga estetik zavq beradi. Uzumning kupaj sharbati nafaqat mazali ichimlik, balki sog‘liqni qo‘llab-quvvatlovchi tabiiy vosita hisoblanadi. Bu sharbatga hech qanday ranglardan foydalanmasdan tabiiy och qizil rangdagi kupaj sharbati olishimiz mumkin.

Xulosa. Ta‘mni yaxshilash kupaj sharbati orqali turli uzum navlarini birlashtirib yaxlit, boy va o’ziga xos ta‘m olish mumkin. Aralash uzum sharbati rang, shirinlik va kislotalilikni yaxshiroq balansda ushlab turadi, bu esa iste‘molchilarga yanada yoqimli mahsulot yaratiladi. U turli xil biologik xususiyatlari tufayli inson organizmini zarur vitamin va minerallar bilan ta’minlab, yurak-qon tomir tizimidan tortib, immunitetni mustahkamlashgacha bo‘lgan ko‘plab jarayonlarni qo‘llab-quvvatlaydi.Turli xil ta‘mlarga ega bo‘lgan sharbatlarni aralashtirish orqali keng iste‘molchi talabini qondirish va yangi ichimlik turlarini yaratish mumkin.

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G‘O‘ZA QATOR ORALARIGA ISHLOV BERISHNING INNOVATSION USULLARI

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Annotatsiya. Tuproq chigit ekilgandan so‘ng ancha zichlashib qoladi, bir tekis ko‘chat undirib olish uchun chigit suvi beriladigan maydonlar va yog‘ingarchiliklardan so‘ng tuproq yanada zichlashgani kuzatiladi. Tuproq zichlashishi natijasida g‘o‘zaning o‘sishi, rivojlanishi sekinlashib, tuproqdagi namlik kamayadi, o‘simlikning oziqlanish, kultivatsiya, sug‘orish sifati buzilib, begona o‘tlarning ko‘payishiga imkon yaratiladi. Bu esa o‘z navbatida g‘o‘zaning o‘sishi, rivojlanishi va xosildorligiga salbiy ta’sir ko‘rsatadi. Shu sababli g‘o‘za qator oralariga ishlov berish, begona o‘tlarga qarshi kurash, tuproqning ustki qatlamini yumshoq xolda saqlash katta ahamiyatga ega.

Kalit so‘zlar. Kultivatsiya, qatlam, donador, zichlashgan, g‘o‘zaning o‘sishi, rivojlanishi, g‘o‘za ildizlari, paxta xosili, zarur chuqurlik.

ИННОВАЦИОННЫЕ МЕТОДЫ МЕЖДУРЯДНОЙ ОБРАБОТКИ ХЛОПКА

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Аннотация. Почва становится намного плотнее после посева семян, области, где семенная вода подается для получения равномерного всходов, и наблюдается, что почва становится более плотной после осадков. В результате уплотнения почвы замедляется рост, развитие хлопчатника, снижается влажность почвы, нарушаются питательные, культивационные, поливные качества растения, создается возможность размножения сорняков. Это, в свою очередь, отрицательно сказывается на росте, развитии и урожайности хлопка. Поэтому большое значение имеет междурядная обработка хлопка, борьба с сорняками, поддержание рыхлости верхнего слоя почвы.

Ключевые слова. Выращивание, отводки, гранулированные, уплотненные, рост, развитие хлопка, корни хлопка, урожай хлопка, необходимая глубина.

INNOVATIVE METHODS OF ROW-BY-ROW PROCESSING OF COTTON

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Andijan Institute of Agriculture and Agrotechnology

Annotation. The soil becomes much denser after sowing seeds, areas where seed water is supplied to produce uniform germination, and it is observed that the soil becomes denser after precipitation. As a result of soil compaction, the growth and development of cotton slows down, soil moisture decreases, the nutritional, cultivation, and irrigation qualities of the plant are disrupted, and

the possibility of weed reproduction is created. This, in turn, negatively affects the growth, development and yield of cotton. Therefore, row-by-row processing of cotton, weed control, and maintaining the looseness of the upper soil layer are of great importance.

Keywords. Cultivation, layering, granular, compacted, growth, cotton development, cotton roots, cotton harvest, required depth.

Tuproqning ustki katlamini mayda donador xolda saqlash tuproqdagi namning bug‘lanishini kamaytirib, sho‘rlangan yerlarning pastki qatlamlaridagi tuzning yuqoriga ko‘tarilishiga yo‘l qo‘ymaslik uchun kultivatsiya o‘tkaziladi.

Qator oralarini kultivatsiya qilishda ishchi organlarining qamrov kengligi, begona o‘tlarning to‘la kesilishiga, egatlar qator orasining o‘rtasidan zarur chuqurlikda olinishiga, g‘o‘za ildizlarining kam shikastlanishiga, tuproqning mayda donador xolda yumshatilishiga erishish lozim. Tuproqning 0,10-10 li mm keladigan donachalari 40% dan kam bo‘lmasdan, 50 mm va undan yiriklari bo‘lmaganda tuproqni sifatli ishlangan deb xisoblash mumkin.

Ilgor fermer xo‘jaliklarida g‘o‘za qator oralariga ishlov berishni g‘o‘za nihollari 75-80% unib chiqqandan so‘ng boshlashadi, bunda qolgan 20-25% nihollar unib chiqishi tezlashadi. Bu ishni barvaqt o‘tkazish begona o‘tlarni tarqalishiga yo‘l ko‘ymaydi, tuproqning yuza qatlamini yumshoq saqlashga imkon yaratib, qatqaloqning zararli ta’sirini oldini oladi.

G‘o‘za ildizlari birinchi kultivatsiya o‘tkazish davrida uncha rivojlanmaganligi sababli qator oralariga ishlov berishda tuproq bilan birga o‘rnidan ko‘zg‘alib, nobud bo‘lishi mumkin. Shuning uchun birinchi kultivatsiya o‘tkazishda ishchi organlarini tuproqka chuqur botmaydigan qilib o‘rnatish lozim.

Sizot suvlari yaqin joylashgan maydonlarda chuqur joylashganga nisbatan qator oralariga ishlov berish tez-tez o‘tkazilishi shart. Sizot suvlari chuqur joylashgan maydonlarda birinchi suvni berishga qadar g‘o‘za qator oralariga bir marta, sizot suvlari yaqin joylashgan maydonlarda esa ikki marta ishlov beriladi. Ob-xavo sharoiti xam xisobga olingan xolda ishlovlar soni o‘zgarishi mumkin. Keyingi kultivatsiyalar g‘o‘zaning sug‘orilishiga qarab, ya’ni xar sug‘orishdan so‘ng tuproq tobiga kelishi bilan o‘tkazilib, bunda tuproq mayda, donador bo‘ladi. Qator oralariga ishlov berish muddati 3-5 kunga kechiktirilgan xolda paxta xosili gektariga 5-8 sentiner kamayadi.

G‘o‘za uncha rivojlanmagan paytda tuproqning mexanik tarkibi yengil bo‘lsa, tuproq ishlov berishga tez yetiladi. May-iyun oylarida sug‘orishdan so‘ng ishlov berish ikki-to‘rt kunda, iyul-avgust oylarida esa g‘o‘za ancha soya berishi sababli tuproq besh-sakkiz kun o‘tganidan keyin yetiladi.

Tuproq unumdorligi past bo‘lishi sababli ko‘p maydonlar sug‘orish va yog‘ingarchiliklar ta’sirida zichlashib ketadi. Buning oldini olish uchun g‘o‘za shonalash davriga qator orasini bir marta chuqur yumshatish turoqning zichligini kamaytirib, o‘g‘it va suvdan foydalanishni yaxshilaydi.

G‘o‘zaning o‘suv davrida uch-besh martagacha sug‘orish o‘tkazilgan maydonlarda to‘rt marta kultivatsiya qilinadi.

Suv taqchil bo‘lgan yillarda kultivatsiya sonini ko‘paytirmasdan, uni sifatli o‘tkazishga, ya’ni sug‘orishdan so‘ng maydonni tuprog‘ini yetilishi bilan ishlov berilishi kerak. Bunda tuproq yaxshi maydalanib, undagi namning bug‘lanishi ancha kamayib, tuproqdagi nam uzoq saqlanadi.

Qator oralarida dastlabki ikki-uch kultivatsiyani sayozrok o‘tkazish, keyingilarini chuqur o‘tkazish maqsadga muvofik. G‘o‘zaning amal-o‘suv davrida o‘simliklarning rivojlanishiga qarab tuproqqa ishlov berish chuqurligi turlicha bo‘ladi. Birinchi kultivatsiyada uning ishchi organlari (ko‘pincha pichoqlar) 6-8 sm, o‘qyoysimon panjalari esa markazga 10-12 sm chuqurlikka tushadigan qilib o‘rnatiladi. Keyingi kultivatsiyalarda esa yumshatgich panjalar yoki tuproqni qatlamlab yumshatadigan KKO ishchi organlaridan foydalaniladi. Yumshatgich panjalar 10-12 sm, g‘o‘zaning gullash davrida esa 8-10 sm chuqurlikka botadigan qilib o‘rnatiladi. Qator oralarini markazini yumshatish uchun o‘qyoysimon panjalar 14-16 sm chuqurlikda joylashtiriladi.

G‘o‘za shonalash davrigacha bir marta chuqur ishlov berish tuproqni zichlanishini kamaytiradi va ildiz rivojlanishiga ijobiy ta’sir etadi. Ikkinchi va uchinchi kultivatsiyalashdan boshlab ximoya zonasi 15-16 sm gacha kengaytiriladi. Qator orasi 60 sm kenglikda ekilganda 32-34 ta, 90 sm kenglikda ekilganda esa 37-39 ta ishchi organ qo‘yilishi maqsadga muvofiq.

Qator orasi 60 sm ni tashkil etgan qatorlarga ishlov berishda qatlamli yumshatish o‘tkazish uchun kultivatorning oltita ishchi organidan ikkita chetkisi o‘simlik qatoridan 10-12 sm nariga 4-5 sm chuqurlikka, ikkinchi jufti 6-7 sm chuqurlikka botadigan qilib, egat o‘rtasiga esa bitta yoki ikkita organ o‘rnatiladi. Ishchi organ ikkita bo‘lgan kultivatorda bittasi 8-10 sm, ikkinchisi 13-14 sm. bitta ishchi organi bo‘lganda esa u 13-34 sm chuqurga botadigan qilib o‘rnatiladi. 90 sm qator oralig‘ida 15-16 sm chuqurlikka moslab o‘rnatilgan xolda o‘tkazilsa tuproqdagi namni bug‘lanishga 10-15% ga kamayadi. Mexanik tarkibi og‘ir, suv o‘tkazish xususiyati past, suv yaxshi singmaydigan tuproqlarda qator oralari 60 sm bo‘lganda o‘rtadagi ishchi organlar 1,5-1,6 sm 90 sm qator oraliqda 16-18 sm chuqurlikka mos kelishi kerak. Bunda 60 sm qator oraligida o‘simlikdan xar ikki tomondan 5-7 sm ximoya zonasi qoldirilib, 45-50 sm kenglikda, 90 sm qator oraligida 75-80 sm kenglikda ishlov beriladi. Oxirgi kultivatsiya o‘tkazishda o‘rtadagi ishchi organlarni chuqurligiga aloxida axamiyat berish kerak, chunki tavsiyadagi chuqurlikdan chukur o‘tkazilsa paxta terish traktorlarini yurishi qiyinlashadi, bir tekis yurmasligi sababli terim sifati pasayib ketadi.

Qo‘shqatorlab ekilgan maydonlarga birinchi ishlov berishda KXU-4 rusumli kultivatorlaridan foydalaniladi. Chigit 90 (60x30) sm sxemada ko‘shqatorlab ekilgan dalalarda g‘o‘za qator oralariga kultivator osilgan traktor g‘ildiraklari orqasiga joylashgan ishchi organlariga g‘o‘za qatoridan 6-8 sm uzoklikda va 6-7 sm chuqurlikda ma’lum burchak xosil qilgan xolda xarakatlanadi, disk ortidan pichoqlar 6-8 sm uzoqlikda va 5-6 sm chuqurlikda, 60 sm egatlarning o‘rtasidan yuradigan g‘ozpanja 12 sm kamrovda va 12-14 sm chuqurlikda tuproqni yumshatib boradi. Tor (30 sm) qatorlar orasidan yuradigan noralniklar tuproq, xolatidan kelib chiqib o‘simlikdan 15 sm uzoqlikda 3,5 sm kamrovli va 7-8 sm chuqurlikda tuproqni yumshatib ketadi. Tor (30 sm) qator orasiga nixollar yosh davrida bir va ikki marta kultivatsiyalashni kichik ishchi organlari bilan amalga oshiriladi.

G‘o‘za qator oralariga ikkinchi marta ishlov berish (kultivatsiyalash) da kultivatorga 31 ta ishchi organlari o‘rnatiladi. 60 sm qator oralaridan yuradigan 18 ta noralniklar o‘simlikdan 10-12 sm uzoq va 7-8 sm chuqurlikda, ikkinchi qator noralniklar birinchisidan 7-8 sm uzoq va 8-10 chuqurlikda, egat markazidan yuradigan g‘ozpanja 12-14 sm chuqurlikda xarakatlanib, 60 sm g‘o‘za qator orasini qatlamma-qatlam yumshatib ketadi.

G‘o‘zani oziqlantirish maksadida tor (30 sm) qatorlar orasiga 2 ta KKO organi va izidan o‘g‘itlagich soshnik o‘rnatiladi. KKO organlari tor (30 sm) qatorlar markazidan 10-12 sm chuqurlikda tuproqni kesib xarakatlanadi va o‘g‘itlagich orqali mineral o‘g‘itlarni 10-12 sm chuqurlikka soliladi,

Shuni aloxida ta’kidlab utish lozimki, tor (30 sm) qator orasiga ishlov berish natijasida tuproq mayin xolatda bo‘lib, namlik yaxshi saqlanadi, begona o‘tlar yo‘qotiladi, tuproqning qavs almashinuvi yaxshilanadi, lekin traktorning tekis yurishi ta’minlanmasa, birinchidan kesaklar paydo bo‘lib, nixollarni ko‘mib ketishga olib kelsa, ikkinchidan tekis yurmasligi xisobiga nixollarni kesib ketadi va natijada ko‘chatni siyraklashishiga olib keladi.

Oxirgi yillarda chigit ekishda yangi har xil davlatlarda ishlab chiqilgan keng kamrovli seyalkalardan foydalanilmoqda, lekin kultivatsiya mavjud kultivatorlardan foydalaniladi xozirda 6 qatorli seyalka va kultivator bilan chigit ekib, g‘o‘za parvarishida 6 qatorli kultivatorlar bilan ishlov berilmoqda. Mashina terimiga mos holda bu maydonlarda ham oxirgi kultivatsiyaga axamiyat berish lozim.

Aeratsiya - bu tuproqning havo bilan ta'minlanishini yaxshilash jarayoni. O'simliklar uchun kislorod zarur, chunki ildiz tizimi nafas olish uchun kisloroddan foydalanadi. Tuproqning yuqori qatlamida kislorod yetishmasligi o‘simliklarning o‘sishini sekinlashtirishi va hatto o‘limiga olib kelishi mumkin. Aeratsiya tuproqni zarur havo bilan ta'minlab, o‘sish va rivojlanishni yaxshilashga yordam beradi.

Aeratsiya jarayonida tuproq yuzasi yoki ichki qatlamlari mexanik tarzda teshiladi yoki bo‘linadi, bu orqali kislorod va havo tuproqning chuqur qatlamlariga kirib boradi. Bu, o‘z navbatida, ildizlarning kislorod olishiga imkon yaratadi va tuproqda namlikni yaxshilashga yordam beradi.

Aeratsiyaning afzalliklari:

Ildiz tizimining sog‘lom rivojlanishi: Aeratsiya tuproqda kislorodning yetarli miqdorda bo‘lishini ta'minlaydi, bu esa o‘simliklarning ildiz tizimini mustahkamlaydi.

Tuproqning suvo‘zligi: Aeratsiya tuproqning suvni o‘zida ushlab turish qobiliyatini yaxshilaydi, shu bilan birga ortiqcha suvning to‘kilishiga yo‘l qo‘yiladi.

O‘simliklarning o‘sishini tezlashtirish: Havo almashinuvi va suvning yaxshi taqsimlanishi o‘sishning tezlashishiga yordam beradi.

Tuproqning optimal tuzilishini saqlash: Aeratsiya tuproqni zichlashmasdan, uning yaxshi strukturasini saqlab qolishga yordam beradi, bu esa o‘simliklarning samarali o‘sishiga xizmat qiladi.

Shu sababli, aeratsiya qishloq xo‘jaligida tuproq sifatini yaxshilash, hosilni oshirish va o‘simliklarning sog‘lom o‘sishini ta'minlashda juda muhim ahamiyatga ega.

Xulosa qilib aytganda, kultivator qator oralariga ishlov berishda juda muhim rol o‘ynaydi. U begona o'tlarni yo‘q qilish, tuproqni aeratsiya qilish, yumshatish va tekislash orqali o‘sish sharoitlarini yaxshilaydi. Shuningdek, o‘simliklarning ildiz tizimining rivojlanishiga yordam berib, suv va oziqa moddalarini samarali taqsimlashga imkon yaratadi. Kultivator yordamida tuproqni samarali ishlov berish, hosilni oshirish va qishloq xo‘jaligi samaradorligini yaxshilash mumkin. Bu texnikaning foydali xususiyatlari, mehnatni engillashtirishi va xarajatlarni kamaytirishi bilan qishloq xo‘jalik ishlari uchun ajralmas vositaga aylangan.

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РЕСПУБЛИКАМИЗДА МАВЖУД ХОМ-АШЁЛАРДАН ҚИШЛОҚ Х ЎЖАЛИГИ МАШИНАЛАРИНИНГ КУЛЬТИВАТОР ЮЛДУЗЧАЛАРИНИ ИШЛАБ ЧИҚАРИШ

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Аннотация. Ушбу мақолада республикамизда мавжуд бўлган хом-ашёлардан фойдаланган ҳолда углеродли пўлатлардан тайёрланган ерга ишлов берувчи машиналарнинг қуйма нинасимон ротацион юлдузчаларининг илмий изланиш натижалари тавсия этилган. Кимёвий-термик ишлов бериш турнинг нитритцементасияси ва ундан кейин toблаш ва паст ҳароратли бўшатиш оптимал режимлари қўлланилган. фермерлар хўжаликлари дала майдонларида экилган ва униб чиққан пахта чигити ниҳолларини ёмғир ёғишдан ёки суғоришдан кейин ҳосил бўладиган қатқалоқларни агротехника талабида нормал юмшатадиган мустаҳкам культиватор юлдузчалари янги инновацион технология асосида ишлаб чиқарилган.

Калитли сўзлар: углеродли пўлат, қуймакорлик усули, қуйма ротацион нинасимон юлдузчалар, структураси, қаттиқлиги, термик мустаҳкамлиги ва тайёр деталларнинг ейилишга бардошлилиги.

ПРОИЗВОДСТВО ЗВЕЗДОЧЕК КУЛЬТИВАТОРОВ ДЛЯ СЕЛЬСКОХОЗЯЙСТВЕННЫХ МАШИН ИЗ СЫРЬЯ, ИМЕЮЩЕГОСЯ В НАШЕЙ РЕСПУБЛИКЕ

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Аннотация. В статье представлены результаты научных исследований по литым звездочкам из углеродистой стали для почвообрабатывающих машин с использованием сырья, имеющегося в нашей республике. Использованы оптимальные режимы химико-термической обработки, азотирования, цементации с последующим отпуском и низкотемпературного отпуска. На основе новой инновационной технологии были изготовлены прочные культиваторные звездочки, которые в соответствии с сельскохозяйственными требованиями обычно размягчают комки, образующиеся после дождя или полива рассады хлопчатника, высаженной и пророщенной на полях фермерских хозяйств.

Ключевые слова: углеродистая сталь, способ литья, литые ротационно-литые звездочки, структура, твердость, термопрочность и износостойкость готовых деталей.

PRODUCTION OF CULTIVATOR STARS FOR AGRICULTURAL MACHINES FROM RAW MATERIALS AVAILABLE IN OUR REPUBLIC

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Annotation. The article presents the results of scientific research on cast carbon steel sprockets for tillage machines using raw materials available in our republic. Optimum modes of chemical-thermal treatment, nitriding, cementation with subsequent tempering and low-temperature tempering were used. Based on the new innovative technology, durable cultivator sprockets were manufactured, which, in accordance with agricultural requirements, usually soften lumps formed after rain or watering of cotton seedlings planted and germinated in the fields of farms.

Key words: carbon steel, casting method, cast rotational cast sprockets, structure, hardness, thermal strength and wear resistance of finished parts.

Бугунги кунда республикамизнинг барча шаҳарлари, вилоятлари, туманлари ва қишлоқларида кўплаб деҳқон ва фермер хўжаликлари фаолият юритмоқдалар. Ҳадемай, шудгор қилинган ерларни текислаш, бороналаш, ҳар хил кенгликда жўялар олиш, экиш ва ишлов бериш усуллари бошланиб кетади. Шулардан энг асосийси республикамиз бойликларидан бири – бу пахта чигитини экиш, ўстириш, суғориш, ишлов бериш усуллари ва пахта йиғим-терими билан якунланади. Аммо бунинг учун деҳқон ва фермер хўжаликларига пахта чигитини экувчи сеялкалар, культивация сеялкалари уч ёки тўрт ғилдиракли тракторлар ҳамда уларнинг эхтиёт қисмлари керак бўлади, сабаби бу тракторлардан йил давомида унумли фойдаланилади. Йилнинг баҳор фаслида апрель ва май ойларида пахта чигитини экиш ишлари бошланади ва ундан кейин тугатилади. Экилган чигитлар ривожланиб, ўниб чиққандан сўнг айрим вақтларда об-ҳаво инжиқликлари бошланади. Айниқса, кучли шамол, дўл ва ёмғир ёғиши ўниб чиққан пахта ер майдонларини қатқалоқ қилиб ташлайди. Қатқалоқ бўлган пахта ер майдонларини юмшатиш учун асосан нинасимон ротацион юлдузчалар керак бўлади, афсуски, бундай юлдузчали деталлар бизни ишлаб чиқаришда мавжуд эмас.

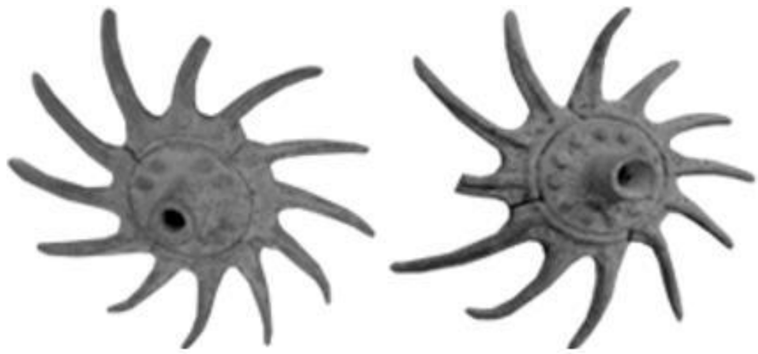
Шунинг учун республикамиз пахта далаларида асосан ишчи инсонлар, айниқса, аёлларимиз ерни чопиш ва юмшатиш ишларини бажаришмоқда (1-расм,а,б), лекин бу билан муаммо ҳал бўлди дегани эмас. Улар жуда оғир шароитда иссиқ кунларда қўл билан меҳнат қилишади, қатқалоқ бўлган пахта эр майдонларини юмшатади ва барча чопиқ ишларини ҳам бажаради. Аммо лекин бу билан муаммо ҳал бўлди дегани эмас, балки барча муаммоларни тўғри қўйиб, уларни ҳал қилиш керакдир. Юртбошимиз томонидан чиқаётган қарорларда ёшлар-инсонлар меҳнатидан эмас, балки қишлоқ хўжалик техникаларидан унумли фойдаланиш, замонавий инноватсион технологияларни яратиш ва шулар асосида янгидан-янги техникалар ва уларнинг эхтиёт қисмларини ишлаб чиқариш масалалари қўйилган. Ана шу масала ва топшириқларни бажариш ҳар биримизнинг ҳақиқий инсоний бурчимиздир.

1-расм. Қатқалоқ бўлган пахта ер майдонларини чопиш ва юмшатиш ишларида аёлларимизнинг меҳнат қилиши тасвирланган.

Юқорида айтиб ўтилган муаммоларни ҳал қилиш учун аввало ҳар хил русумли машиналар ва тракторлар ҳамда уларнинг тўлиқ комплект деталлари керак бўлади. Бу тракторлардан унумли фойдаланилади, шу билан бирга бу техникаларнинг ишчи деталлари маълум бир агротехник талабларга жавоб бериши керак. Кўпчилик тракторларнинг ишчи қисмлари ва деталлари ишқаланишга ишласа, айримлариники эса фақат абразив ейилишга ишлайди [1]. Бундай деталларнинг ейилишга бардошлилиги пўлатларнинг таркибига, ички структура тузилишига ва механик хоссаларига боғлиқдир. Шу боис бу деталлар ўрта ва юқориуглеродли сифатли пўлатлардан тайёрланиши керак, акс ҳолда узоқ муддат ишлаши анчага чекланади [2]. Экув тракторлари доимо техник жиҳатдан ишга соз ҳолатда бўлиши керак. Бунинг учун улар таъмирланиб тайёрланади, барча деталлари, қисмлари ва механизмлари тўлиқ текширилади, баҳоланади ва тракторланинг бажараётган ишлари доимий назорат қилиб борилади.

Бундан кўриниб турибдики, қишлоқ хўжалик машиналари ва тракторлари унумли ишлаши учун уларга яроқли материаллар танлаш ва кейин қўллаш зарур. Мана шундай деталлар жумласига ерга ишлов берувчи қишлоқ хўжалик машиналаридаги қотқолоқларни 4-8 мм гача чуқурликгача юмшатувчи, юза сирти қуриган ерларни юмшатиб, бегона ўтларни илдизи билан кесиб ташловчи нинасимон ротацион юлдузчалар киради. Бу нинасимон юлдузчалар – мотигалар бундан 15-20 йиллар аввал Россия Федерацияси заводларида кулранг чўяндан қуйиб олинган, аммо унинг ишлаш муддати 40-80 г ошмаган, яъни тез ейилиб ёки синиб ишдан чиққан [3]. Энг асосийси хорижий валюта ҳисобида сотиб олинган ва республикамиз худуди далаларида ишлатилган. Аммо бугунги кунда бундай юлдузчалар бизда йўқлиги сабабли дала майдонларида ишлатилмайди.

Тегишли ташкилотлар ва деҳқон-фермерларнинг маълумотларига кўра, кулранг чўяндан тайёрланган нинасимон юлдузчаларнинг ишлаш муддати унча кўп эмас, масалан, кулранг чўяндан қуйиб олинган деталлар максимум 40-80 г ишлагандан сўнг тез ейилиб, қийшайиб синиб кетган (2-расм), сабаби шуки, деталь материали жуда мўрт ва пластик, мустаҳкамлиги эса жуда пастдир [4]. Бу ерда шуни айтиш керакки, республикамизга охирги ўн беш ёки йигирма йил давомида бундай нинасимон юлдузчалар умуман олиб келинмаган ва ишлатилмаган. Лекин бунинг ўрнига бошқа ясама қўлбола деталлардан фойдаланилган [5], аммо улар ерга керакли чуқурликгача ишлов бера олмаган ва агротехника қоидаларига умуман мос келмаган. Шу боис пахта экинлари ва бошқа ҳар турли сабзавот экинларининг унумдорлиги кескин камайиб кетган. Бундай ишларни олдини олиш учун мустаҳкам ва сифатли деталлар ишлаб чиқариш талаб этилади.



2-расм. Иш жараёнида тез ейилиб-қийшайган ва синиб кетган юлдузчаларнинг умумий кўринишлари.

Юқорида айтиб ўтилган камчиликларни бартараф этиш мақсадида Ислом Каримов номидаги Тошкент давлат техника университети механика-машинасозлик факультети «Материалшунослик» кафедраси, «Қуймакорлик технологияси» кафедраси билан ҳамкорликда профессор-ўқитувчилар ва илмий мустақил-изланувчилар томонидан қуйма нинасимон ротацион юлдузчаларнинг такомиллаштирилган шакли ва ўлчамлари (3-расм,а,б) Тошкент «Агрегат заводи» АЖ нинг қуймакорлик цехини ер формасида углеродли конструкцион пўлатдан қуйиб олишнинг янги инновацион технологияси ишлаб чиқилди [6]. Бу технологияга асосан қуйма нинасимон юлдузчалар 30Л, 35Л пўлатларидан қуйиб олинди.

Яратилган янги инновацион технологияга асосан қуйма нинасимон ротацион юлдузчаларнинг кимёвий таркиби, тузилиши ва механик хоссалари Тошкент «Агрегат заводи» АЖ марказий лабораториясида текширилди ва таҳлил қилинди. Текширув натижалари шуни кўрсатдики, нинасимон юлдузчаларнинг кимёвий таркиби 30Л пўлатининг таркибига мос келади, негаки 30Л пўлати «Ўзбекистон металлургия комбинати» АЖ нинг пўлат эритувчи цехида қуйиб олинади. Шунинг учун ҳам бу янги технологияни республикада мавжуд бўлган хом-ашёлардан фойдаланган ҳолда ишлаб чиқдик. Бизга маълумки, республикамиздаги гигант корхоналардан бири «Ўзбекистон металлургия комбинати» АЖ да ҳар хил маркали Ст20, 25, 30, 35, 40 пўлатлар эритилади ва улардан турли хил деталлар ва махсулотлар ишлаб чиқарилади ҳамда республикада мавжуд бўлган саноат корхоналарининг эҳтиёжлари учун ишлатилади. Қуйидаги 3-расмда тайёр қуйма нинасимон юлдузчанинг тўлиқ йиғилган тайёр ҳолати тасвирланган.

3-расм. Қуйма нинасимон ротацион юлдузчанинг тўлиқ йиғилган ҳолатининг кўриниши.

Ушбу янги технология бўйича 30Л, 35Л маркали пўлатларидан қуйиб олинган намуналарнинг кимёвий таркиби лаборатория шароитида таҳлил қилинди, структура тузилишлари МИМ-8М ва замонавий оптик ва электрон микроскопларда ўрганилди, пўлатнинг қаттиқликлари юмшатилган ҳолати Бринелда (HB), тобланган ҳолати Роквелда (HRC), микроқаттиқликлари ПМТ-3 (HV) ўлчанди ва керакли натижалар олинди [7].

Комплекс ҳолда кимёвий-термик ишлов берилган, яъни нитроцементация қилинган ва сўнгра тоблаб бўшатилган қуйма нинасимон ротацион юлдузчалар дала синови учун ҳар бир далага 2 тадан 6 комплект тайёрланди. Тўлиқ йиғиб тайёрланган юлдузчали деталлар республикамизнинг Тошкент вилояти Бўка тумани, Сирдарё вилояти Оқолтин тумани, Жиззах вилояти Гагарин туманининг фермер хўжаликларида дала синови ўтказилди. Илмий-тадқиқот ишининг асосий янгилиги сифатида кимёвий-термик ишлов беришнинг нитроцементация усули ва ундан кейин тоблаш ва бўшатиш турлари қўлланилган. Нитроцементациядан мақсад шуки, қуйма нинасимон юлдузчаларнинг ташқи юза иш сиртида қатлам ҳосил қилиш ва уни термик ишлов бериш усулининг тоблаш ва бўшатиш усулларини қўллаб, деталнинг юза қаттиқлиги ва мустаҳкамлигини юқори, ўзагини эса нормал қовушқоқ қилиб олиш ҳамда юлдузчаларнинг ейилишга бардошлилигини ва узоқ ишлаш муддатини 3-4 баробарга оширишдир [8]. Бу янги инновацион технология Тошкент «Агрегат заводи» АЖ га татбиқ этилган ва юқори иқтисодий фойда олишга эришилган.

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CHORVA MOLLARINI BOQISHDA ISHLATILADIGAN DAG‘AL OZUQALARNING FIZIK-MEXANIK XOSSALARI

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Annotatsiya. Qishloq xo‘jaligi ishlab chiqarishida qoramol xo‘jaliklarida ozuqa tayyorlash va tarqatish uchun turli tizimli va texnologik sxemalar qo‘llaniladi. Xo‘jaliklarda yosh qoramollarni boqishning yeng keng tarqalgan texnologiyasi ko‘chma tarqatgichlar tomonidan ozuqa tarqatishdir. Kichik qoramol fermalari uchun ozuqa tayyorlash va tarqatish jarayonlarining o‘ziga xosligi ushbu xo‘jaliklarda ozuqa tarqatishni mexanizatsiyalash uchun o‘ziga xos yechimlarni ishlab chiqish zaruratini ko‘rsatadi. Shuni hisobga olib kichik xo‘jaliklar uchun ozuqa tarqatishda qo‘llaniladigan qurilma ishlab chiqildi va tarqatiladigan ozuqalarning fizik-mexanik xossalari tadqiq etildi. Tajribalar natijalariga ko‘ra,tarqatiladigan dag‘al ozuqalar sifatida maydalangan somon, maydalangan beda va maydalangan makkajo‘xori tanlab olindi hamda ularning hajmiy massasi va tabiy uyumlanish burchagi aniqlandi.

Kalit so‘zlar. hajmiy massa, tabiiy uyumalanish burchagi, dag‘al ozuqalar, maydalangan makkajo‘xori, maydalangan somon, maydalangan beda, o‘rtacha kvadratik chetlashishi.

ФИЗИКО-МЕХАНИЧЕСКИЕ СВОЙСТВА ГРУБЫХ КОРМОВ, ИСПОЛЬЗУЕМЫХ В КОРМЛЕНИИ СКОТА

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Аннотация. В сельскохозяйственном производстве применяются различные структурно-технологические схемы приготовления и раздачи кормов в животноводческих хозяйствах. Наиболее распространенной технологией кормления молодняка КРС в хозяйствах является раздача корма мобильными разбрасывателями. Специфика процессов приготовления и раздачи кормов для мелких животноводческих ферм показывает необходимость разработки конкретных решений по механизации раздачи кормов в этих хозяйствах. С учетом этого было разработано устройство, используемое при раздаче кормов для небольших фермерских хозяйств, и изучены физико-механические свойства раздаваемых кормов. По результатам экспериментов в качестве распределяемых грубых кормов были выбраны измельченная солома, измельченная люцерна и измельченная кукуруза, определены их объемная масса и естественный угол наклона.

Ключевые слова. объемная масса, естественный угол ворса, грубые корма, молотая кукуруза, молотая солома, молотая люцерна, среднеквадратическое отклонение.

PHYSICO-MECHANICAL PROPERTIES OF ROUGHAGE USED IN FEEDING LIVESTOCK

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Annotation. In agricultural production, various structural and technological schemes for the preparation and distribution of feed in livestock farms are used. The most common technology for feeding young cattle on farms is the distribution of feed by mobile spreaders. The specificity of the processes of preparation and distribution of feed for small livestock farms shows the need to develop specific solutions for the mechanization of feed distribution on these farms. Taking this into account, a device was developed for distributing feed for small farms, and the physical and mechanical properties of the distributed feed were studied. Based on the results of the experiments, chopped straw, chopped alfalfa and chopped corn were selected as distributed roughage, their volumetric mass and natural tilt angle were determined.

Keywords. bulk density, natural pile angle, roughage, ground corn, ground straw, ground alfalfa, standard deviation

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Kirish. Hozirda yirik chorvachilik fermalariga mo‘ljallangan ozuqa tayyorlash va tarqatish qurilmalari mavjud, shu bilan birga kichik chorvachilik fermer xo‘jaliklari va shaxsiy oilaviy xo‘jaliklarda qo‘llash uchun ozuqa maydalagich qurilmalar ishlab chiqilgan. Ammo kichik xo‘jaliklar uchun ozuqa tarqatish qurilmalari yo‘qligi sababli mazkur ishlar qo‘l mehnati bilan amalga oshirilmoqda. Bu esa ish sifatining past, mehnat sarfining esa yuqori bo‘lishiga olib kelyapti [1].

Qishloq xo‘jaligi ishlab chiqarishida qoramol xo‘jaliklarida ozuqa tayyorlash va tarqatish uchun turli tizimli va texnologik sxemalar qo‘llaniladi. Xo‘jaliklarda yosh qoramollarni boqishning yeng keng tarqalgan texnologiyasi ko‘chma tarqatgichlar tomonidan ozuqa tarqatishdir. Kichik qoramol fermalari uchun ozuqa tayyorlash va tarqatish jarayonlarining o‘ziga xosligi ushbu xo‘jaliklarda ozuqa tarqatishni mexanizatsiyalash uchun o‘ziga xos yechimlarni ishlab chiqish zaruratini ko‘rsatadi [2].

Hozirgi vaqtda jahon amaliyotida ozuqani harakatga keltirib, maydalash va aralashtirish operatsiyalarni birlashtirgan omixta ozuqa tarqatgichlar keng joriy etilgan bo‘lib, bu ozuqani tayyorlash va tarqatish uchun operatsion va boshqa harajatlarning kamayishiga olib keladi. Ammo bu ozuqa tarqatkichlar yirik chorvachilik xo‘jaliklari uchun mo‘ljallanganligi sababli 5-10 bosh qoramolga yoki 50-60 bosh qo‘yga ega kichik xo‘jaliklarda foydalanilganda yaxshi samara bermaydi [3].

Shu sababli kichik oilaviy chorvachilik xo‘jaliklaridagi chorva mollari uchun maydalangan dag‘al ozuqalarni belgilangan kunlik ratsion bo‘yicha sifatli bir xil me’yorda tarqatib beradigan qurilmani ishlab chiqish dolzarb hisoblanadi.

Dag‘al ozuqalarni tarqatish texnologik jarayonini o‘rganishda tarqatigich parametrlarini asoslash uchun dag‘al ozuqalarning ba’zi bir fizik-mexanik xossalarini o‘rganish kerak bo‘ladi[4, 5.].

Chorvachilik xo‘jaliklarida chorva mollariga dag‘al ozuqalarni maydalab berishda ular har bir chorva molining turiga qarab belgilangan o‘lchamda maydalab beriladi, ya’ni zootexnik talablar bo‘yicha maydalangan ozuqalarning uzunligi qora mollar uchun 3-5 cm oraliqda, qo‘y va echkilar uchun 1-3 cm bo‘lishi lozim. Yuqoridagilarni hisobga olib, dag‘al ozuqalarni tarыatishda foydalaniladigan qurilma konstruksiyasini va parametrlarini asoslash keyingi tadqiqotlarda zarur bo‘ladigan dastlabki ma’lumotlar sifatida xo‘jaliklarda eng ko‘p foydalanilayotgan dag‘al ozuqalardan maydalangan makkajo‘xori, bug‘doy somoni va beda poyalarining fizik-mexanik xossalari o‘rganib chiqildi.

Materiallar va usullar. Maydalangan makkajo‘xori, somon va beda poyalarining fizik-mexanik xossalarini aniqlash bo‘yicha tajribalar GOST 20915-2011. “Selskoxozyaystvennaya texnika. Metodы opredeleniya usloviy ispыtaniy” va “Physical properties of plant and animal materials” me’yoriy xujjatlarida keltirilgan uslublar asosida olib borildi [6, 7].

Ushbu uslubiy qo‘llanmalar asosida ishlab chiqilgan tadqiqotlar dasturiga maydalangan bug‘doy somoni, beda pichani va makkajo‘xori poyalarining uzunligi, qalinligi, massasi va ularning tashkil etuvchilarini o‘zaro nisbati, zichligi, ishqalanish burchagi va koeffitsientini aniqlash kiritildi [8].

Maydalangan makkajo‘xori, somon va beda poyalarining o‘lcham-massa ko‘rsatkichlarini aniqlashda o‘lchash asboblari sifatida chizg‘ich, ruletka, shtangensirkul, AOTE elektron tarozi, Wile 55 namlik o‘lchagichidan, qiya tekislik qurilmasi va tabiy uyumlanish burchagini aniqlovchi maxsus burchak o‘lchovchi transportiyor asbobidan foydalanildi (1-rasm).

1-tarozi; 2-ruletka; 3-namlik o‘lchagich; 4-shtangensirkul; 5-chizgich

1-rasm. O‘lchov asboblari

Tajribalarda olingan natijalarga matematik statistika usullari bilan ishlov berilib, ularning statistik tavsiflari, ya’ni o‘rtacha qiymati $M_{o‘rt}$, o‘rtacha kvadratik chetlashishi σ, variatsiya koeffitsienti V va boshqalar aniqlandi.

Maydalangan dag‘al ozuqalarni tarqatish qurilmalarini ishlab chiqishda ishlov beriladigan materialning holati, ya’ni tarqatishga mo‘ljallangan maydalangan dag‘al ozuqalarning hajmiy massasi va tabiy uyumlanish burchagini bilish zarurdir[9].

Tajribani o‘tkazishda dag‘al ozuqalarni, ya’ni maydalangan somon, beda va makkajo‘xori poyalarining hajmiy massasini aniqlash uchun har bir komponentni 30 martadan takrorlab, hajmi 1 m^3 ga to‘g‘ri keladigan silindrik idishdagi ozuqaning massasi AOTE elektron tarozida tortilib, ozuqaning hajmiy massasi quyidagi ifoda yordamida aniqlandi:

$$M_V = \frac{M_g}{V_b} = \frac{M_g}{\pi R^2 h} \quad (1)$$

bu yerda, M_g – 1 m^3 hajmli silindrik idishdagi dag‘al ozuqaning massasi,kg;

V_b – idish hajmi, m^3 (1 m^3 ga teng);

R – bunker radiusi, m (R=0,5 m);

h – bunker balandligi, m (h=0,5 m).

Natijalar va ularning tahlili. Tajriba natijalariga ko‘ra dag‘al ozuqalarning hajmiy massasi ya’ni maydalangan somonning o‘rtacha qiymati 64,7 kg, o‘rtacha kvadiratik chetlanishi 4,35, variatsiya koeffitsenti 6,72 % ni, maydalangan bedaning o‘rtacha qiymati 114,5 kg, o‘rtacha kvadiratik chetlanishi 5,13, variatsiya koeffitsenti 4,48 % ni va maydalangan makkajo‘xori poyasining o‘rtacha qiymati 125,3 kg, o‘rtacha kvadiratik chetlanishi 3,68, variatsiya koeffitsenti 2,94 % ni tashkil qilganini ko‘rishimiz mumkin (1 – jadval).

1 – jadval

Maydalangan dag‘al ozuqalarning hajmiy massasi

№	Poya turi	Hajmiy massasi, kg			O‘rtacha kvadratik chetlanish, σ	Variatsiya koeffitsi-yenti, V, %
		X_{min}	X_{max}	O‘rtacha qiymat, $M_{o‘rt}$		
1	Somon poyasi	58	71	64,7	4,35	6,72
2	Beda poyasi	108	124	114,5	5,13	4,48
3	Makkajo‘xori poyasi	120	131	125,3	3,68	2,94

Maydalangan dag‘al ozuqalarning tabiiy uyumalanish burchagini aniqlash uchun ozuqalarning erkin tukilishini ta’minlovchi ma’lum bir balandlikda joylashgan voronkali idish va uyumlanish burchagini aniqlovchi maxsus burchak o‘lchovchi transportyor asbobi yordamida har bir ozuqa turi bo‘yicha 30 martadan takrorlab alohida o‘lchandi (2-rasm).

2-rasm. Tabiiy uyumalanish burchagini aniqlash

Maydalangan dag‘al ozuqalarning tabiy uyumlanish burchagini aniqlanganda maydalangan somonning o‘rtacha uyumlanish burchagi 29^{O}, uning o‘rtacha kvadratik chetlanishi 3^{O}, variatsiya koeffitsenti 10,53 % ni, maydalangan bedaning o‘rtacha og‘ish burchagi 32^{O}, o‘rtacha kvadratik chetlanishi 2^{O}, variatsiya koeffitsenti 8,84 % ni va maydalangan makkajo‘xori poyasining o‘rtacha og‘ish burchagi 34^{O}, o‘rtacha kvadratik chetlanishi 4^{O}, variatsiya koeffitsenti 11,67 % ni tashkil qilganini ko‘rishimiz mumkin (2 – jadval).

2– jadval

Dag‘al ozuqalarning tabiy og‘ish burchagi

№	Poya turi	Sochiluvchanlik burchagi, grad			O‘rtacha kvadratik chetlanish, σ	Variatsiya koeffitsi-yenti, V, %
		X_{min}	X_{max}	O‘rtacha qiymat, $M_{o‘rt}$		
1	Somon poyasi	25	33	29	3	10,53
2	Beda poyasi	28	36	32	2	8,84
3	Makkajo‘xori poyasi	26	38	34	4	11,67

Xulosa. Yuqoridagi tajribalar natijalariga ko‘ra, tarqatiladigan dag‘al ozuqalarning hajmiy massasi o‘rganilganda maydalangan somon bo‘yicha o‘rtacha 49,8 kg/m^3 ni, maydalangan bedada o‘rtacha 90,1 kg/m^3 ni va maydalangan makkajo‘xorida o‘rtacha 101,9 kg/m^3 ni tashkil etishi aniqlandi.

Tarqatiladigan dag‘al ozuqalarning tabiiy uyumalanish burchagi aniqlanganda maydalangan somonning o‘rtacha uyumlanish burchagi 29^O ni, maydalangan bedaning o‘rtacha uyumlanish burchagi 32^O ni va maydalangan makkajo‘xorining o‘rtacha uyumlanish burchagi 34^O ni tashkil etishi aniqlandi.

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PERFORMANCE ANALYSIS OF A GREENHOUSE FAN-PAD COOLING SYSTEM IN HOT AND DRY CLIMATE CONDITIONS: GRADIENTS OF HORIZONTAL TEMPERATURE AND RELATIVE HUMIDITY

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Abstract. An experimental study is conducted to determine the performance parameters of system, as well as gradients of temperature and humidity along greenhouse when opening Fan-Pad cooling system. Measurements in the study were carried out by using seven sensors for different locations, as well as portable instruments. For this purpose, the five digital temperature and humidity sensors and two pyranometers were used during experiments. Among them, two were located outside greenhouse for external measurements. The rest one pyranometer above the crop canopy, four temperature and humidity sensors were mounted within the crop canopy along the greenhouse. Four sensors were placed according to positions defined between pad and fan. According to the experiment results, the non-uniform temperature changes, but approximately uniform humidity changes due to the crop transpiration were observed along greenhouse from pad panels to exhaust fans. When the cooling system closed, hourly mean temperature and relative humidity from Pad to Fan inside greenhouse changed between 30-33 °C and 30-47%, respectively, at outside climate conditions of 32 °C and 25%. After providing stabile cooling by opening Fan-Pad system, hourly mean temperature and relative humidity along greenhouse from pad to fan ranged between 20-27 °C, and 50-68%, respectively. The air temperature entering to greenhouse with air velocity of 0.8-0.9 ms-1 through pad was approximately 12-13 ºC lower than the outside air temperature. The air temperature from Pad to Fan increased approximately by 7 ºC. The method of psychometric calculations was employed to determine the cooling efficiency of Fan-Pad system. According to the calculation result, the average of air temperatures inside greenhouse was 24.5 ºC after achieving stable cooling for outside air temperature of 31.4 ºC. The hourly mean cooling effect and cooling efficiency calculated for Fan-Pad system were determined to be 6.96 ºC and 76.8%, respectively.

Keywords: Cooling efficiency; Fan-Pad cooling system; Greenhouse; Psychometric calculation; Temperature and relative humidity.

Introduction. Throughout the year, the demand for fresh vegetables and fruits has increased from day to day. In order to increase the amount of production of vegetables and fruits in dry areas, the greenhouse production period during the summer and autumn seasons can be expanded. However, the accumulated heat within the greenhouse due to the presence of high solar radiation causes to rising of the internal temperature (Tashoo et al 2014). Extreme temperatures inside the greenhouse will limit the plant growth, as well as its quality, eventually resulting in plant wilting and death. Even in greenhouses with proper and adequate circulation, the leaf temperature can be 5 – 10 °C higher than the air temperature (von Zabeltitz 2011).

Greenhouse crops must not be kept for long time at temperatures between 30 and 35 °C (Bailey 2006). If level of air temperature in greenhouses where is used natural ventilation and shading system is higher than 28 °C, it is recommended using of an artificial cooling system. Generally, evaporative cooling for greenhouses are made by using fogging, Fan-Pad cooling and misting methods (von Zabeltitz 2011). The system in which is suitable for hot and dry climate conditions among these is the Fan - Pad cooling system. A Fan-Pad system consists of cellulose Pad panels, exhaust fans, water circulation pump and pipes. Pads and exhaust fans are located on opposing walls to cool plants growing in between Pad and Fan. Cellulose Pads have corrugated surfaces which are suitable for passing water and air. When inlet air passes through the wetted Pads, water evaporates using its sensible heat. In thermodynamics, this is known as an adiabatic process in which remains the constant of enthalpy without heat loss or gain (ASHRAE 2005).

Theoretical and experimental studies have been conducted by many researchers on Fan-Pad evaporative cooling systems. According to results of Kittas et al (2001) and Jain & Tiwari (2002), the internal greenhouse temperatures were lower about 10 °C and 4-5 °C than outside temperature, respectively. Kittas et al (2003) presented and validated a model to predict the temperature and humidity gradient along the length of a large greenhouse equipped with Fan-Pad cooling system. Willist (2003) proposed a numerical model to predict air and crop temperatures when cooling system is used, not used.

Fuchs et al (2006) developed a numerical model based on energy balance equation for evaporative cooling. Sabeh et al (2006) studied on amount of water needed for the cooling system to be used in a semi-arid region. Sethi & Sharma (2007) reviewed the available cooling technologies such as ventilation, shading, evaporative cooling (Fan-Pad, misting, fogging, and roof cooling) and composite systems (earth-to- air heat exchanger system and aquifer coupled heat exchanger system). Kumar et al (2009) reviewed on cooling technologies, design parameters, and their effects on the microclimate. Malli et al (2011) tested experimentally the thermal performances for three different cellulose Pad thicknesses, such as 75, 100 and 150 mm. Lopez et al (2012) analyzed the characteristics of airflow and temperature distribution both Fan-Pad system and a low pressure fogging using sonic anemometry in an empty greenhouses. In this paper, an experimental study was conducted to determine gradients of temperature and humidity formed along a greenhouse cooled when Fan-Pad system is used in Ankara conditions. The performance parameters of cooling system were calculated by using the method of psychrometric calculation according to external and internal data related with greenhouse environment.

2. Material and Methods

2.1. Greenhouse experiments

The experiments were conducted in a tomato greenhouse from April to August of 2009 at typical summer days with dry, sunny and cloudless. The crop was grown in a Venlo style research greenhouse located at University of Ankara, Turkey (39° 57’ 39” N, 32° 51’ 49” E, and 855 m altitude).

The floor area of the greenhouse is 64 m2 (8 m x 8 m). The orientation of greenhouse is east-west direction with an angle of 26.6º from North. The greenhouse with galvanized steel frame is covered with polycarbonate sheets at thickness of 4 mm with double-walled and UV protection. The gutter and ridge heights of greenhouse having the roof slope of 26.5° are 3 m and 4 m, respectively. General dimensions and position of the greenhouse are shown in Figure 1. The greenhouse has six roof vents south- facing and two vents north-facing, and is equipped with Fan-Pad cooling system, as well as drip irrigation system. During the experiments, the tomato crop was grown in a soil medium.

The greenhouse climate system consists of natural ventilation, shading, Fan- Pads cooling, high-pressure fogging, drip irrigation, infrared heaters, and computer controller. During experiments, natural ventilation, shading, irrigation and Fan-Pad systems were actively used to ensure proper climate for growing crop.

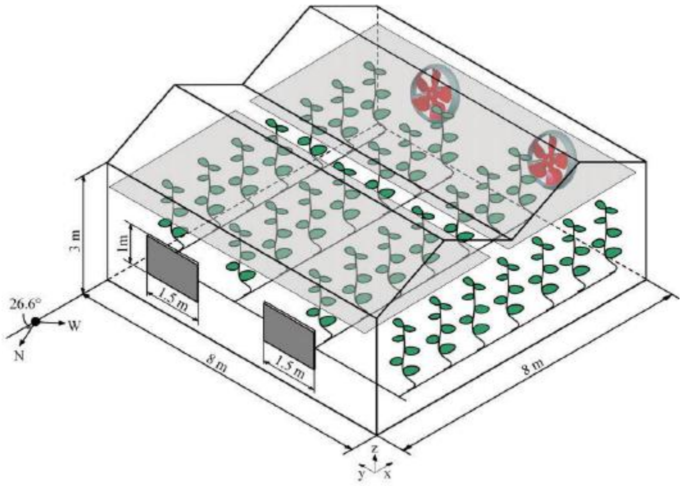

Figure 1- Schematic of experiment greenhouse used for cooling experiments

Tomato (Lycopersicon esculentum L.) seedlings were transplanted into the greenhouse on April 01, 2009. The crop was configured in seven rows with 14 plants in each row, total 98 plants, as illustrated in Figure 2. Row spacing and plant spacing were 0.9 m and 0.4 m, respectively. Water need of plants is provided with drip irrigation system which has dripper discharge rate of 2 L h-1. A cable-drum drive system is used to extend and retract from truss to truss for shading of crop in greenhouse. The shading nets with solar transmittance of 50% in two-pieces at height of 2.5 m above ground are available in the greenhouse. However, the small sun flecks are occurrence on crop in the greenhouse by reason of the space of 1 m between these nets (Figure 2).

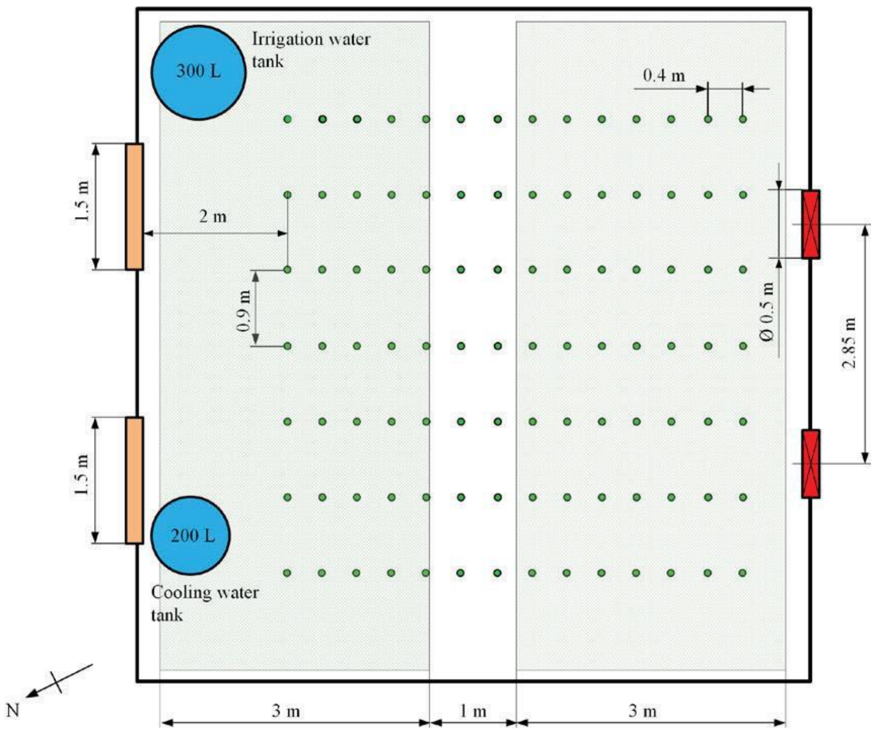

Figure 2- Configuration of crop, drip irrigation system Fan-Pad cooling system, and shading nets in experiment greenhouse

2.2. Fan-Pad cooling system

Evaporative cooling Pads that are at thickness of 100 mm are placed in two frames, width of 1.5 m and height of 1 m. They mount on the bonded gas concrete wall that is at height of 0.75 m above ground at north side. The distance between the pads and the first canopy line in rows was approximately 2 m. Two exhaust fans are mounted to opposite side of the greenhouse as shown in Figure 2. The rotation axis of fans, which have the diameter of 0.5 m, is at a height of 1.6 m above ground. The spacing between rotation axes of fans on side wall is 2.85 m. Air flow capacity of each fan with 0.37 kW electrical motor power is 7 m3 h-1 at zero static pressure. Airflow directions from Pad to Fan are parallel to the crop rows.

A submersible water pump in water tank of 200 L has flow rate of 6 m3 h-1 at head of 3 m. The water lost by evaporation from water tank is compensated from the tap water via floating valve. The water flow amount passing through the Pads is controlled by return valve.

2.3. Measurements

Measurements related with greenhouse environment were carried out by using seven sensors at different positions, as well as portable instruments. For this purpose, the five digital temperature and humidity sensors (SHT75, accuracy: ± 0.3 °C for temperature and ±1.8% for humidity, Sensirion, Zurich, Switzerland) and two pyranometers (CM6, accuracy: ± 5 Wm-2, Kipp and Zonen, The Netherlands) were used. Among them, two were located outside greenhouse for external measurements. The rest one pyranometer above the crop canopy, four temperature and humidity sensors were mounted within the crop canopy along the greenhouse.

Furthermore, a portable thermo-hygrometer (AZ8721, accuracy: ± 0.5 °C for temperature and ±2% for humidity, AZ Instrument, Shangai, China) and a portable hot wire anemometer (Lutron AM4204, accuracy: ± 0.8 °C for temperature and ±1% for air velocity, Taipei, Taiwan) were used for instrumentation at different locations for greenhouse experiments.

SHT75 is a digital sensor with high accuracy, which is fully calibrated at the factory. SHT75 sensors were used together with programmable PIC16F628 microcontroller-based data acquisition modules (Microchip, AZ, USA). Each module was connected to a desktop computer over single serial bus line based on RS-232 settings (2400 baud rate, 8 data bits, no parity, and 1 stop bit) for serial data transmission. Temperature and humidity data were measured for every one minute, and were recorded in text files. Readings coming from two pyranometers were logged for every 30 minutes. Data logged were monitored by using a GUI program written in Borland Delphi 7. Wind speed data were taken from records of meteorological station in campus.

The sensor positions are illustrated in Figure 3 with numbers given from (1) to (7). (1): outside temperature and humidity sensor, (2-3-4-5): inside temperature and humidity sensors, (6): inside pyranometer, and (7): outside pyranometer. The sensors with numbers of (1-6-7) were mounted on a metal stand at 2.2 m of height from the ground outside greenhouse. The sensors with numbers of (2-3-4-5) were placed at intervals of 2.2 m at heights of 1.25 m above ground within the crop canopy along the greenhouse. These four sensors were named as “very close to pad”, “next to pad”, “middle”, and “next to fan”, respectively.

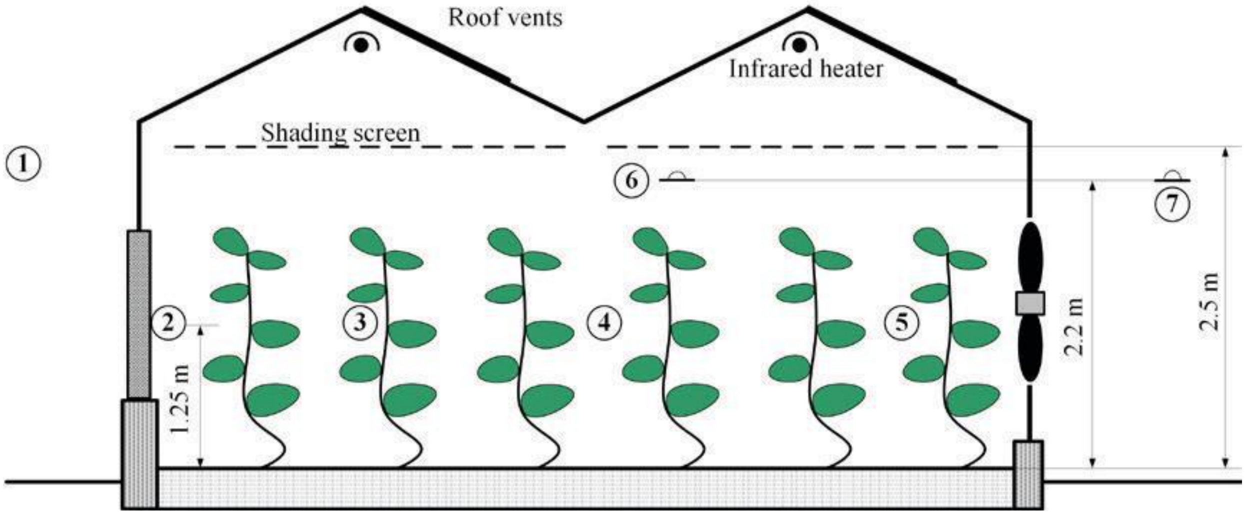

Figure 3- Positions of sensors placed inside and outside greenhouse, 1 … 5, temperature and humidity sensors; 6-7, pyranometers

2.4. Performance parameters

The difference between the outside temperature and inside temperature can be used as an important parameter to describe the cooling performance of Fan-Pad system. For this purpose, as an easy criterion, the cooling effect of Fan-Pad system is calculated from

$$\Delta t_{ce} = t_o - t_i \tag{1}$$

Where; t_o, outside air temperature (°C); t_i, inside air temperat temperature (°C).
The cooling efficiency (η) is determined as the ratio between the drop in air temperature after passing through the Pad and the maximum drop under conditions of air saturation.

$$\eta = \frac{t_{db}(1) - t_{db}(2)}{t_{db}(1) - t_{wb}(1)} \times 100 \tag{2}$$

Where; η, cooling efficiency (%); $t_{db}(1)$, the outside dry-bulb temperature of entering air to Pad (°C); $t_{db}(2)$, the dry-bulb temperature of leaving air from Pad (°C); $t_{wb}(1)$, the outside wet-bulb temperature of entering air to Pad. However, two psychrometric properties of entering air to the system must be known:

1. Dry bulb temperature and the wet-bulb temperature, or
2. Dry bulb temperature and relative humidity

If both dry bulb temperature (tdb) and the wet-bulb temperature t_{wb} is measured directly, the cooling efficiency can be calculated by substituting into equation (2). If dry-bulb temperature (tdb) of air and relative humidity (rh) are known, its wet-bulb temperature (twb) can be calculated by using psychrometric equations. The method of psychrometric calculations due to sensors used at measurements was employed to determine the cooling efficiency of evaporative Fan-Pad system.

2.5. Method of psychrometric calculation

The following psychrometric equations given by ASHRAE (2005) were used in all calculations. Relative humidity is defined as the ratio of the water vapor pressure to the saturation water vapor pressure at all temperatures and pressures:

$$rh = \frac{P_w}{P_{ws}} \tag{3}$$

The humidity ratio (W, also known as moisture content or mixing ratio) of a given moist air sample is defined with following equation as functions of partial pressure of water vapor and total pressure (Pa):

$$W = 0.62198 \frac{P_w}{P - P_w} \tag{4}$$

2.6. Adiabatic saturation process

Evaporative cooling is an adiabatic process at constant enthalpy that is no heat loss and heat gain. It utilizes the exchange of energy between air and water. The energy needed to evaporate water is taken from the air, thus reducing air temperature. The energy in the air can be divided into two parts: sensible heat and latent heat. Sensible heat is a quantitative measure of the air temperature. Latent heat is the energy needed to evaporate the water in the air.

The enthalpy balance as follows to calculate the humidity ratio of moist air for the adiabatic condition must be defined (ASHRAE 2005):

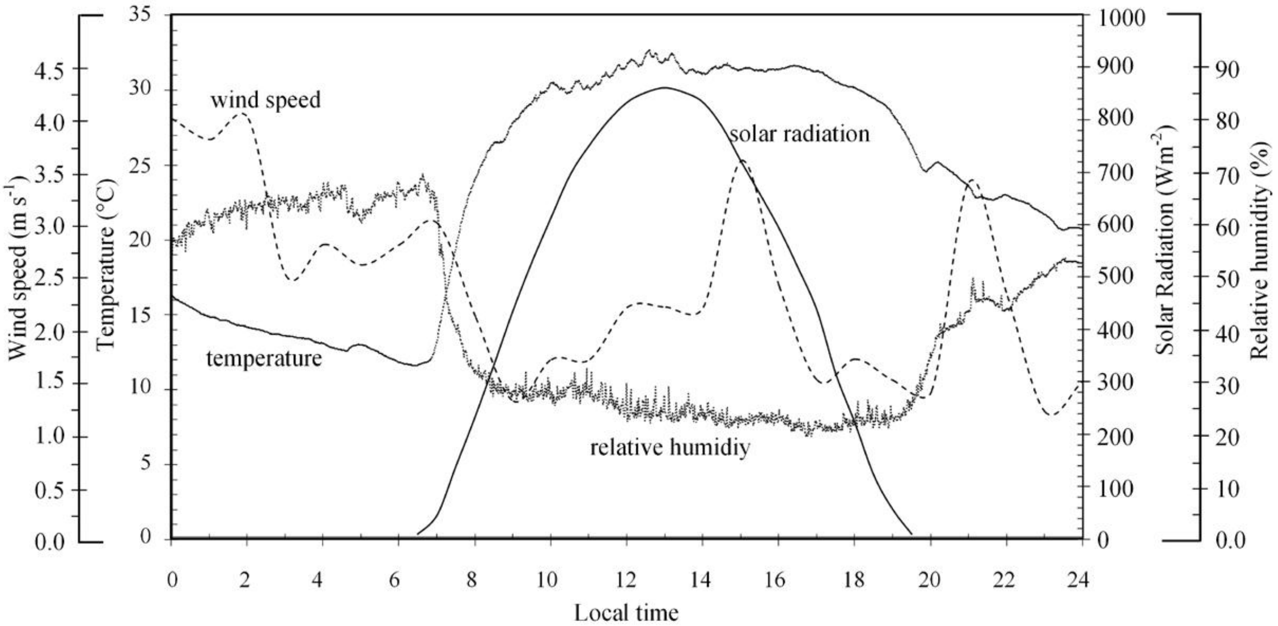

Figure 4- Daily variations of solar radiation, temperature, humidity, wind speed data measured outside greenhouse (26 August 2009)

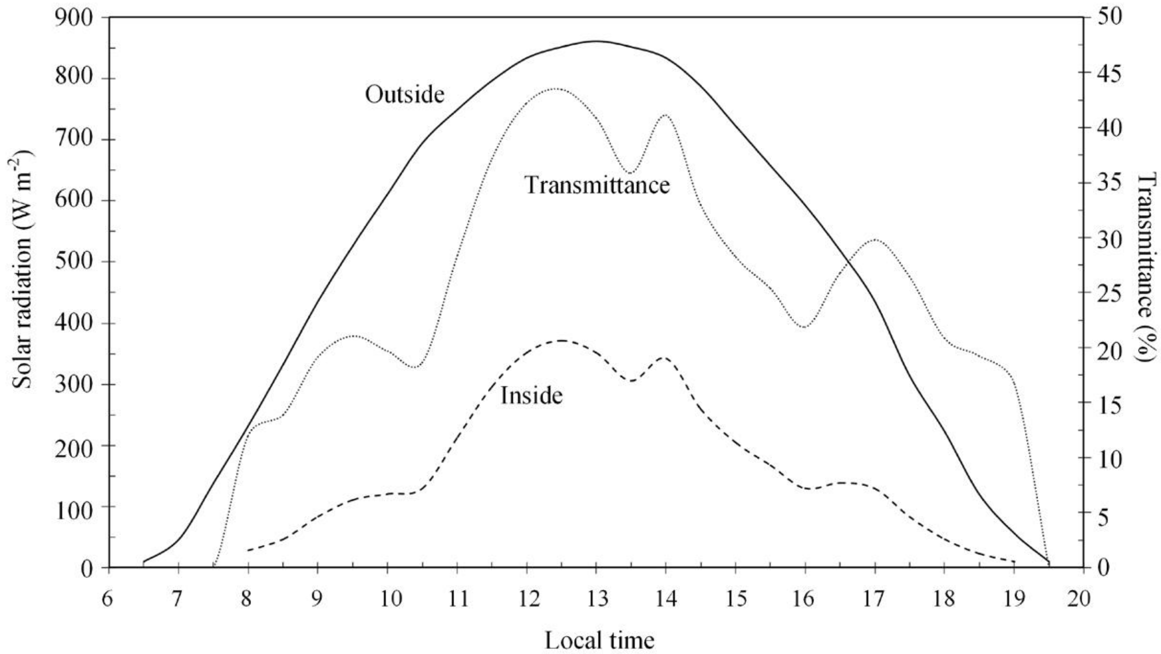

Figure 5- Daily variations of internal and external solar radiation (26 August 2009)

stages which turned off the cooling system. The other of which was 14:00 – 15:00 time stage which turned on the system. At these time stages, the levels of hourly mean solar radiation prevailing above plants were approximately 350 Wm-2 (cooling off), and 270 Wm-2 (cooling on), respectively.

The variations of temperature and humidity along greenhouse were evaluated for two time stages. When turning off system between 12:00 and 13:00, the levels of hourly mean temperature calculated for 2, 3, 4 and 5 sensors positions were approximately 33 °C, 31 °C, 32 °C, and 30 °C, respectively, along the horizontal axis from Pad to Fan, After turning on Fan-Pad system, when being stable cooling conditions between 14:00 and 15:00, levels of hourly mean temperature for 2, 3, 4 and 5 sensors positions dropped to approximately 20 °C, 24 °C, 27 °C, and 26°C, and air at these points were colder as much as 12.75 °C, 6.6 °C, 4.9 °C and 3.8 °C, respectively.

When turning off Fan-Pad system, the levels of hourly mean humidity calculated for 2, 3, 4 and 5 sensors positions were approximately 30%, 41%, 39%, and 47%, respectively. It must be emphasized that the relative humidity levels inside greenhouse were more because of crop transpiration, even turning off the system. At 14:00 – 15:00, levels of hourly mean humidity calculated for 2, 3, 4 and 5 sensors positions rose up to approximately 68%, 56%, 50%, and 57%, respectively. The air at measurement positions along greenhouse was more humid as much as 38%, 15%, 11% and 10%, respectively. These results are integrated in Table 1 for both temperature and humidity gradients.

Our results are consistent with findings of past studies by Kittas et al (2001, 2003); Bartzanas & Kittas (2005); Al-Helal et al (2006); Teitel et al (2010); Lopez et al (2012) related to the temperature and humidity distributions. For example, in a study performed by

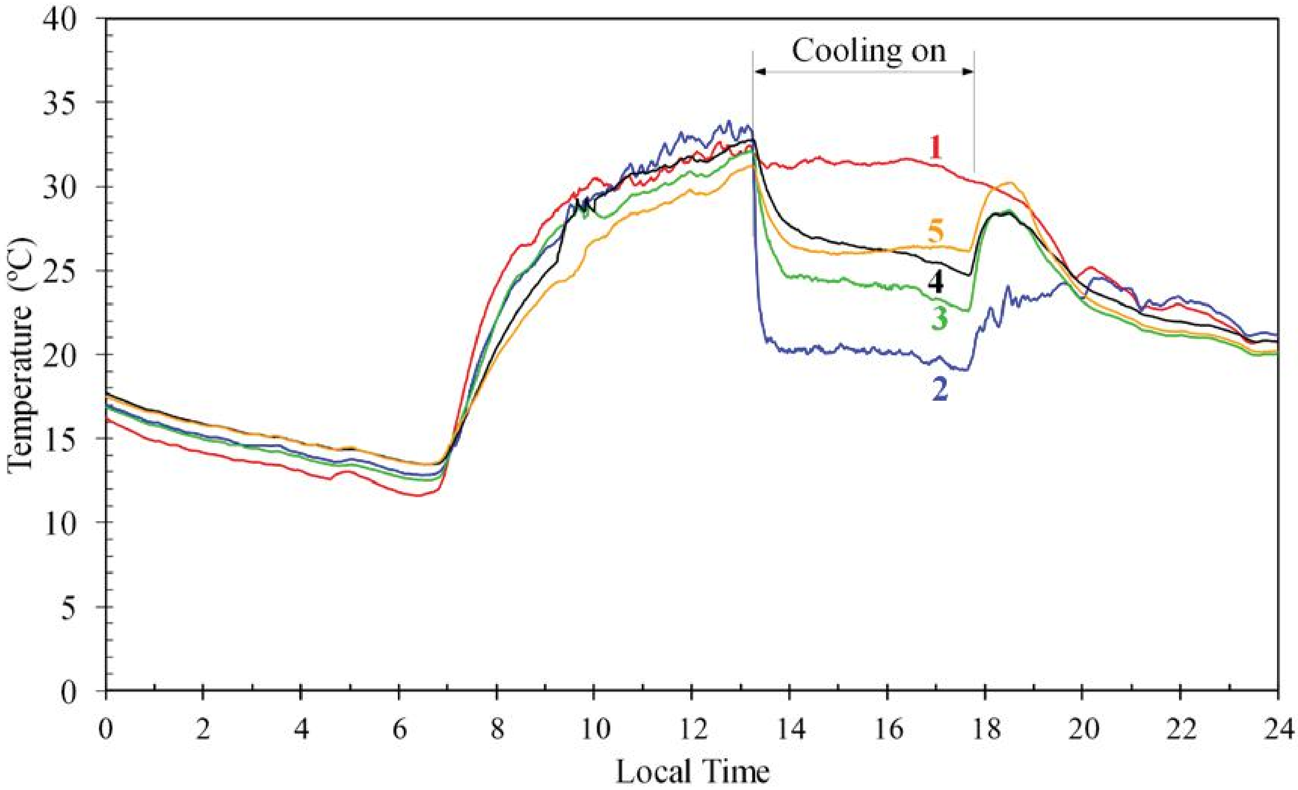

Figure 6- Daily variations of temperatures measured at different locations outside and inside a greenhouse cooled with Fan-Pad system (26 August 2009); Sensor positions: 1, outside; 2, pad; 3, next to pad; 4, middle; 5, next to fan.

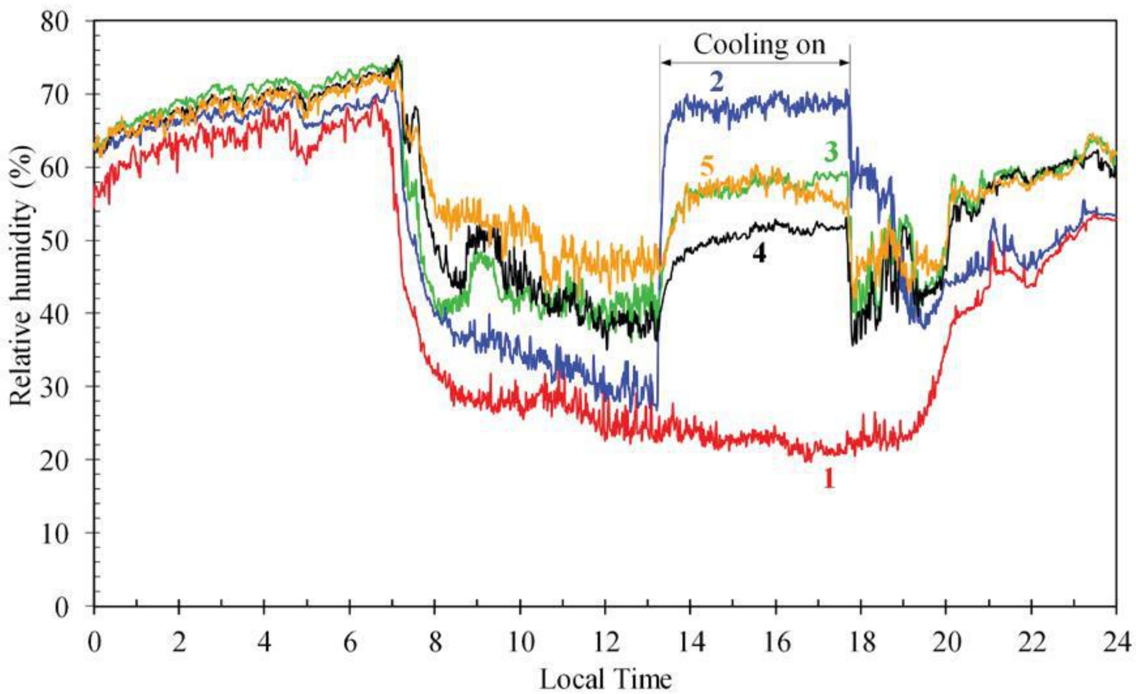

Figure 7- Daily variations of relative humidity measured at different locations outside and inside greenhouse of a greenhouse cooled with Fan-Pad system (26 August 2009); Sensor positions: 1, outside; 2, pad; 3, next to pad; 4, middle; 5, next to fan.

Table 1- Gradients of temperature and humidity according to sensor positions during periods turning off (12:00 – 13:00) and on (14:00 – 15:00) of cooling system

		Sensor positions				
		Outside	*Pad*	*Next to pad*	*Middle*	*Next to fan*
		1	*2*	*3*	*4*	*5*
Temperature	Off	32.05(0.29)	33.02(0.41)	31.10(0.45)	31.93(0.39)	30.02(0.52)
(S.D.)	On	31.44(0.175)	20.27(0.13)	24.50(0.13)	27.04(0.30)	26.18(0.16)
°C	Δt	-	12.75	6.60	4.89	3.84
Humidity	Off	24.69(1.51)	29.52(1.48)	41.06(1.77)	38.55(1.09)	46.79(1.59)
(S.D.)	On	23.09(1.09)	67.96(0.89)	56.50(0.49)	49.67(0.66)	56.98(0.94)
%	Δrh	-	38.44	15.44	11.12	10.19

Bartzanas & Kittas (2005), the difference between the air temperature entering to greenhouse and outside air temperature was about 10 °C. In a research study carried out in a greenhouse equipped with Fan-Pad system by Lopez et al (2012), the inside air temperature was cooler up to 11.6 °C than that of a natural ventilated greenhouse. However, it is emphasized that the main drawback of the Fan-Pad system was the horizontal temperature gradients to be with a maximum difference of 11.4 °C between the pads and fans. So far, however, there has been little discussion about horizontal humidity gradients between Pad and Fan.

Figure 8 shows the gradients of temperature and humidity along horizontal profile of greenhouse.

Plotting drawn in Figure 8 indicates increasing approximately linearly of temperature between Pad and Fan. It can be said that the humidity variations along greenhouse remain approximately stable between Pad and Fan because of the crop transpiration. Giving details, the temperature increased up to x=4 m, then decreased. The humidity decreased up to x=3 m, and then remained stable. In other words, it was emphasized that the temperature at x=4.4 m was slightly higher while the relative humidity was lower due to small sun flecks arising from gap between two shading curtains. Kittas et al (2001; 2003) also reported the similar results on rose plants, which showed to be significantly differences on temperature and humidity at experiments with and without shading nets. If a general evaluation is made to define temperature and humidity profiles at x-direction, the second – degree polynomial trend lines and equations can be derived with R2=0.9946 and R2=0.974, respectively (Figure 8).

Figure 9 shows the detailed performance parameters including cooling effect (Δtce) and cooling efficiency (η), as well as temperatures (to, twb t2, and ti) which correspond to external temperature, wet-bulb temperature, temperature in front of pad, and internal temperature, respectively. Here, ti represents the average of inside air temperatures that are measured at the four points inside greenhouse. Experiments results consist of cooling off (12:00 – 13:00) and cooling on (14:00 – 15:00) time stages. As indicated in Figure 9, initially, before starting Fan-Pad system, the inside air temperature was higher or close to the outside air temperature. After starting system, the inside air temperature dropped until reaching to equilibrium.

However, this reduction did not happen immediately, there was always a transition stage. The period when the cooling system is on includes "transition stage" and "stable cooling stage" (Figure 9). There are very significant differences between two time stages in terms of temperature variations and performance values.

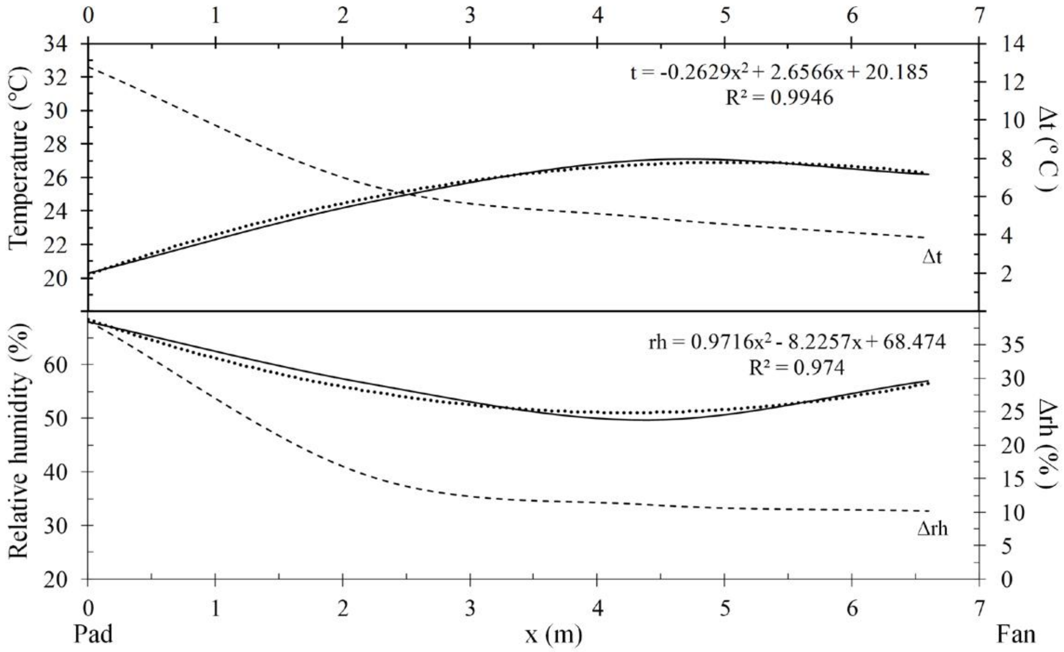

Figure 8- Gradients of temperature and humidity along greenhouse

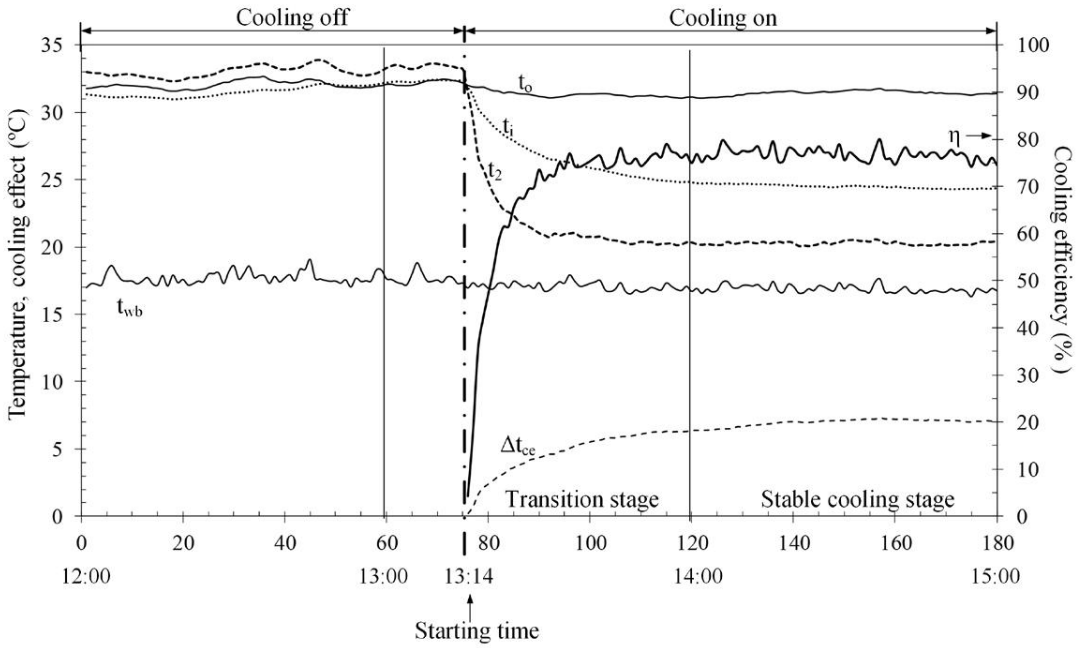

Figure 9- Performance parameters of Fan-Pad cooling system: cooling effect, cooling efficiency and temperature levels

The results obtained related with the performance of greenhouse cooling system during experiments are summarized in Table 2. According to the calculation results, the internal temperature was 24.5 °C while external temperature was 31.44 °C. It was observed that the internal temperatures were lower than external temperatures when turning on Fan-Pad system. This is an indication that sensible heat is converted to latent heat by water evaporation (Li & Willits 2008). Values of the cooling effect and cooling efficiency of Fan-Pad system were found to be Δtce = 6.96 °C and η=76.8%, respectively. The maximum cooling efficiency was 80% at stable cooling stage. Bartzanas & Kittas (2005) also found that the cooling efficiency of the pad-fan system was approximately 80%.

The mean air temperature entering to greenhouse with air velocity of 0.8 m s-1 through the wet pad was 20.3°C. It was observed that the cooled air temperature levels passing the wet pad with air velocity of 0.8-0.9 m s-1 were approximately 12-13 °C lower than the outside air temperature. The maximum air velocity measured in front of Pads inside of the greenhouse was 0.9 m s-1, but as moving away from Pads, it was observed that the air velocities reduced up to 0.2 – 0.3 m s-1 in crop rows, which were also consistent with results obtained by Li & Willits (2008); Lopez et al (2012). ASABE (2008) has recommended the mean air velocity of 1.27 m s-1 entering to the greenhouse through the pad.

Table 2- Performance quantities of Fan-Pad cooling system: mean, minimum and maximum values

Quantities	*Symbol*	*Mean (S.D.)*	*Minimum*	*Maximum*
Outside temperature (°C)	t_o	31.4(0.17)	31.1	31.8
Wet-bulb temperature (°C)	t_{wb}	16.9(0.27)	16.3	17.6
Temperature in front of pad	t_2	20.3(0.13)	20.1	20.6
Inside temperature (°C)	t_i	24.5(0.14)	24.3	24.7
Cooling effect (°C)	$\Delta t_{ce} = t_o - t_i$	6.96(0.26)	6.4	7.3
Cooling efficiency (%)	η	76.8(1.31)	74.1	80.0

However, if applying the high air velocities on Pads, increasing electricity costs and decreasing cooling efficiency. According to our experiment results, it can be emphasized that the air velocities of 0.8-0.9 m s-1 are appropriate to provide the efficient cooling. The efficiency of Fan-Pad system is an indicator of air saturation efficiency. The closer temperature measured in front of pad inside greenhouse is to wet- bulb temperature, higher cooling efficiency of pad.

However, it is emphasized that the highest efficiency values can be produced at low air velocities (Franco et al 2014). As the air velocity decreases, the length of time that the air comes into contact with the water increases, also increasing the saturation of the air, consequently the saturation efficiency is higher (Franco et al 2010). According to experiment results of Franco et al 2014, it was provided that the maximum values of Fan-Pad cooling system efficiency were between 71% and 69% at low air velocities close to 0.5 m s-1.

According to our experimental findings, the cooling system efficiencies ranged between 74% and 80% at air velocities of 0.2-0.3 m s-1 measured in crop rows.

Willits (2003) suggested the higher air-flow rates than 0.05 m3 m-2 s-1 for Fan-Pad system to provide efficient cooling. Air flow rate of fans used in our system is 0.06 m3 m-2 s-1 at zero static pressure. These air flow rates are suitable for adequate cooling. Although the length of the greenhouse is not long, the significant temperature and humidity gradients were observed, which become the coolest air near the pads and the warmest air near exhaust fans of the inside air temperature. The levels of these gradients are affected by many factors, such as greenhouse geometry, positions of shading nets, external climate conditions, air flow rate, crop density and temperature of circulating water. The efficiency of cooling system was quite high due to the dry and warm outside climate conditions. Increasing the air flow passing the pad does not improve the air saturation efficiency. Circulation fans can be used to provide the uniform temperature distribution between pads and exhaust fans.

Conclusions. This study evaluated the cooling performance of a greenhouse cooled with Fan-Pad under hot and dry climate conditions like in Ankara. During experiments, natural ventilation, shading, irrigation and Fan-Pad systems were actively used to ensure proper climate for growing crop.

In order to define greenhouse experiment conditions, the external and internal data including solar radiation, wind speed, temperature- humidity and internal air velocity were measured. The temperature and humidity profiles were determined along horizontal axis between Fan and Pad. The evaluations were made for the different sensor positions: external, very close to Pad, next to Pad, middle, and next to Fan. It was observed that there were the significant temperature and humidity gradients along the greenhouse from Pad to Fan, even being a small greenhouse where the experiments were made about Fan-Pad cooling.

The levels of these gradients are affected by many factors, such as greenhouse geometry, positions of shading nets, external climate conditions, fan air flow rate, crop density and temperature of circulating water. According to the horizontal temperature and humidity profiles, the second – degree polynomial trend lines and equations were derived.

The performance evaluations were made by using two quantity, such as the cooling effect and cooling efficiency. In order to determine the cooling efficiency of Fan-Pad system, the method of psychrometric calculations was used. The wet-bulb temperatures were calculated by using an iterative procedure. The results obtained showed that the cooling efficiency was low at starting time. For this purpose, two stages, a transition stage and stable cooling stage, were defined. The cooling efficiency increased until reaching to the equilibrium between sensible heat and latent heat for adiabatic cooling process. The hourly mean cooling effect and cooling efficiency performance parameters, as well as the average of air temperatures inside greenhouse, were calculated.

Cooling efficiency is a function of pad temperature, outside temperature and its wet-bulb temperature. The closer pad temperature measured in front of pad inside greenhouse is to wet-bulb temperature, higher cooling efficiency of pad. In order to provide the more effective cooling, there is no need to increase the airflow rate; however, if water temperature circulating in the system and the external air humidity can be reduced, the cooling efficiency can be increased. Furthermore, the circulation fans in the greenhouse can be used for the uniform temperature and humidity distribution.

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AGRICULTURAL ADVANCEMENTS IN KASHKADARYO REGION: DEVELOPMENT OF GRAIN, COTTON, AND RICE CULTIVATION

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Abstract. The article highlights the development of agriculture in the Kashkadarya region, specifically focusing on wheat, cotton, and rice cultivation processes. It discusses the expansion of grain crops in Bahoriston district, the wheat harvesting process in Kasbi district, and measures taken to combat pests in storage facilities. Additionally, the article covers the acceleration of cotton harvesting through mechanization and achievements in rice cultivation. These efforts contribute to ensuring food security and increasing agricultural production.

Keywords: Agriculture, wheat harvesting, cotton cultivation, rice farming, yield, combine harvester, pest control, agrotechnics, Bahoriston district, Kasbi district, Kashkadarya region.

Introduction. Agriculture is one of the key sectors of the country's economy and plays a crucial role in providing the population with food products. In recent years, significant changes have been made in Uzbekistan's agricultural sector to increase efficiency, boost productivity, and introduce advanced technologies. In particular, achievements have been recorded in grain, cotton, and rice farming in the Kashkadarya region.

This article discusses the increase in grain production in the Bahoriston district, the grain harvesting process in the Kasbi district, cotton cultivation and harvesting, as well as the results achieved in rice farming. Additionally, attention is given to measures for combating warehouse pests, agro-technical practices, and ensuring the quality preservation of the harvest.

Results and discussion. The first President of the Republic of Uzbekistan, I.A. Karimov, emphasized the fundamental role of the agricultural sector in the initial stage of reforms and the country's transition to a market economy. He stated, "The issues of fundamentally reforming and rapidly developing the agricultural sector are of crucial importance in the early stage of reforms and in Uzbekistan's strategy for transitioning to a market economy. We have set ourselves the task of ensuring the advanced development of rural areas and restructuring agriculture on a fundamentally new basis[1].

The reforms were not limited to the establishment of new ministries, concerns, and companies but also aimed at aligning the management system of agriculture and related sectors with the requirements of a market economy. The ongoing reforms under state leadership are creating favorable conditions for attracting both domestic and foreign investments into the sector. These measures ultimately contribute to the further development and increased efficiency of agriculture.

According to a decision of the Cabinet of Ministers, in 1992, 224 state farms were transformed into collective farms due to their poor economic conditions, and their property was transferred to collective ownership. Special attention was given to the process of privatization and de-statization of agricultural property. The development of private ownership was prioritized, as it was believed that real landowners would use their property rationally and efficiently [3].

In Uzbekistan, 85.6% of water resources were used for agricultural needs. On September 2, 1993, the Law of the Republic of Uzbekistan "On Water and Water Use" was adopted, serving as a key regulatory document governing water resource management. The water usage system was developed by water management authorities, and water was allocated based on special usage permits and quotas. Water acquisition and accounting were conducted under agreements with water management authorities. Irrigation and water supply were carried out through main canals, reservoirs, and other water management facilities, while water use operations were implemented according to internal farm and water system plans.

Further legislative reforms strengthened the legal framework for land use and agricultural management. On April 30, 1998, the Land Code of the Republic of Uzbekistan was adopted. This code consists of 14 chapters and 91 articles, covering all regulations regarding land categories and their utilization. Article 1 of the code states, "Land is a national asset and serves as the foundation of the life, activity, and well-being of the people of the Republic of Uzbekistan; therefore, its rational use is essential and is protected by the state[6]."

Additionally, on the same date, the Law "On Agricultural Cooperatives (Shirkat Farms)" was enacted. According to this law, a shirkat farm is an independent economic entity with legal status, based on voluntary membership, share contributions, and family contracting. It is primarily engaged in agricultural production but is also authorized to process raw materials, manufacture various products, engage in trade, conduct repair and construction work, and provide services to legal and physical persons. Furthermore, the law outlines the procedures for establishing and managing shirkat farms, membership rules, land allocation, and governance structures. Each member of the cooperative was allocated shares in land and property, ensuring their vested interest in the success of the enterprise.

In Bahoriston district, the volume of grain production has increased. Part of the cotton fields was allocated for grain crops, and in 1995, wheat was sown on 500 hectares, yielding a rich harvest. In 1996, grain fields were further expanded by 2,000 hectares. In 1996, it was planned to cultivate grain on 10,500 hectares. While sowing on irrigated lands has been completed, planting on rainfed lands is still ongoing. Meeting the population's demand for grain products is one of the main tasks of the district administration, and successful efforts have been made in this regard [4].

Despite difficult conditions, the region’s cotton growers worked tirelessly to achieve high yields. Only 4 days remained to fulfill the state order, but the harvesting process slowed down. The fact that the annual plan was being fulfilled 0.05% less each day was causing concern. Therefore, no one had the right to slow down the cotton harvest.

The cotton farmers of Guzar district overcame challenges and secured a leading position in the region. The local administration and farm leaders took all necessary measures to fulfill the state order ahead of schedule. If work had been organized efficiently in other districts as well, the results could have been even better.

Machinery was also actively involved in the cotton harvest. From the second half of October, cotton-picking machines were put into operation. They worked efficiently in Nishon, Chiroqchi, and Guzar districts. For example, out of 70 machines in Kasbi district, 43 were operational in the fields, while in Nishon district, 52 out of 92 units were in use. This ensured a stable continuation of the cotton harvest.

Kasbi, Qarshi, and Kitob districts demonstrated exemplary performance in cotton harvesting. Even after fulfilling their annual targets, they continued to contribute to the region’s “White Gold” reserves.

Additionally, volunteer workers also rushed to the fields to assist. Every day, volunteers from Qarshi city traveled to help ease the labor of cotton growers. Their dedication played a crucial role in ensuring the harvest was collected on time [2].

Alongside achievements in cotton cultivation, rice farming also saw progress. The "G‘alaba" collective farm in Kasbi district gained significant experience in rice cultivation. In 1993, 22 tons of rice were harvested, while in 1994, 18 tons were collected from 5 hectares. By the fourth year of independence, yields had increased to 60 centners per hectare, totaling 30 tons of rice. This result proved that rice cultivation was possible even in arid regions.

Currently, the farm is engaged in providing grain products to the population at affordable prices. To reduce production costs, a local mill was built, eliminating the need to transport rice elsewhere for processing into grain products.

In 1995, grain products were sold at a price of 3-5 soms, and it was planned that prices would not be increased in 1996 either.

This initiative not only boosted economic efficiency but also ensured social protection for the population, serving as a true example of public welfare.

The grain harvest continued intensively in Kasbi district. In the Hamza Hujakulov collective farm, harvesting was carried out on 1,500 hectares. Ten combine harvesters were involved in the process, three of which were modern "Case" combines imported from the United States. Under the leadership of experienced mechanics G‘ayrat Momanov, Tolib Xidirov, and Hamza Ismatov, 10-15 hectares of grain were harvested daily. Before the harvesting season, combine operators attended specialized courses to improve their skills. According to the farm's management chairman, Ergash Tursunqulov, the plan for the current year was to produce 2,700 tons of high-quality grain, with combine operators playing a significant role in achieving this goal. Harvesting operations were also actively carried out in Nishon, Kasbi, Muborak, and Bahoriston districts [7].

During the harvesting process, it is crucial to combat warehouse pests to preserve the quality and quantity of grain. Many microorganisms and insects negatively affect the quality and germination of grain. To prevent the spread of storage pests in the country’s warehouses, mills, and elevators, special measures were implemented. Warehouses were cleaned, repaired, and treated with special chemical agents in a timely manner. In pest control, preparations such as Karbofos, Actellic, Ambush, and Decis were used. Additionally, fumigation methods with methyl bromide, Phostoxin, and Saztoxine were applied. These measures played a crucial role in preserving the quality and volume of the harvest.

Advanced practices were also applied in horticulture. The "Yakkabog‘" company in Yakkabog‘ district, one of the largest horticultural farms in the region, planned to harvest 2,820 tons of apples from 521 hectares of orchards, 200 tons of other fruits, and 3,000 tons of grapes from 261 hectares of vineyards this year. According to the company’s chairman, Shuhrat Beknazarov, gardeners strictly followed agro-technical guidelines to ensure a bountiful harvest. During the autumn-winter season, mineral and organic fertilizers were applied between the rows of orchards and vineyards, and irrigation was carried out. Old fruit trees on 46 hectares were replaced, and 250 hectares of land were prepared for walnut saplings. Experienced gardeners, led by Samad aka Uzoqov, worked on further increasing productivity. In the fall, 58 hectares of land were sown with grain, and exemplary irrigation practices were implemented. Thanks to the dedicated efforts of the gardeners, a plentiful harvest was expected [5].

Cotton sowing operations also continued at a rapid pace. In 1996, the Kashkadarya region planned to produce 420,000 tons of cotton, with 2,900 sowing seeders operating efficiently across the region. Guzar district was one of the first to complete cotton sowing on 12,300 hectares, planting

"Yulduz" and "Bukhoro-6" varieties. The "Yangikent," Meli Rahmonov, and Abdulla Tursunov collective farms carried out exemplary work. Sowing operations were also completed in the Qamashi, Chiroqchi, and Yakkabog‘ districts. Overall, fast-maturing cotton varieties were sown on 173,000 hectares across the region this year.

Conclusion. The agrarian reforms carried out during Uzbekistan’s years of independence aimed to restructure agriculture in accordance with the requirements of a market economy. As a result of state-led reforms, private ownership in agriculture developed, and an efficient system for managing land and water resources was established. Significant achievements were made in the cotton, grain, rice, and horticulture sectors, with increased production and improved efficiency. Foreign investments were attracted, and modern technologies were introduced, enhancing productivity and sustainability. These measures not only boosted the agricultural sector but also contributed to rural development, economic growth, and improved living standards. Ultimately, Uzbekistan’s agricultural reforms laid a strong foundation for long-term food security and self-sufficiency.

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EVAPORATIVE COOLING TECHNOLOGIES FOR GREENHOUSES: A COMPREHENSIVE REVIEW

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Abstract: Excessive heat generation by the high solar radiation is the major issue for agricultural greenhouses in hot climatic regions. This issue has become the great concern for summer greenhouses and has continuously been under study. Effective cooling of greenhouses needs to be undertaken to minimize the issue. There are several techniques of greenhouse cooling and among them, evaporative cooling has completely revolutionized the system of cooling in greenhouses since the nineteenth century and still it is being used around the world. The current paper presents a review study covering the past and the latest kinds of evaporative cooling techniques, which have been utilizing for agricultural greenhouses in summer. The paper attempted to show the performance characteristics of the individual cooling systems, like fan-pad systems, fog cooled systems, roof cooling systems, dissector pad-fan systems, two-stage cooling system and seawater greenhouse systems. A brief survey of literature revealed that evaporative cooling could be applied to any environmental condition to reduce greenhouse excess thermal load depending upon the types of the system. Finally, some innovative cooling ideas have been provided for further studies.

Keywords: evaporative cooling, greenhouse, fan-pad system, fog-cooled, roof cooling, two-stage evaporative cooling.

Introduction. The greenhouses are developed for the purpose of quality production which cannot be produced in an open field due to adverse climatic conditions. In hot climatic regions, greenhouse cultivation is characterized by high solar thermal load that creates major problems inside the environment of the greenhouse and restricts plant growth. According to Castilla et al. (2005), the growth and quality of the crop inside a greenhouse are commonly affected when temperatures are below 12ºC or above 30ºC. In this context, it is very much necessary to remove excess heat load from the greenhouse during hot periods. There are numerous techniques by which favorable microclimate could be maintained in a greenhouse for effective plant growth. In mild temperature regions, natural ventilation is the most common technique to moderate greenhouse microclimate. But natural ventilation frequently fails to extract the excess thermal load in high radiation periods.

In order to remedy this fan ventilation can be incorporated as a substitution to extract excess heat. In some of the cases, shading nets (inside or outside the greenhouse) are very much effective to restrict solar radiation in which a part of solar radiation enters into the greenhouse. Again, though shading net decreases the heat load and air temperature, low intensity of light may decrease plant growth rate. Roof whitening also reduces greenhouse thermal load as some of the solar radiation reflected back to the atmosphere. Among the above-mentioned techniques, evaporative cooling systems are the most effective way for the reduction of greenhouse excess thermal load owing to high levels of solar irradiation during hot periods. Evaporative cooling in greenhouses is usually accomplished by natural or fan ventilation to enhance its cooling performance.

In an evaporative cooling process, heat and mass exchange occur between air and water. The sensible heat of air is transferred into the water and when this heat becomes equivalent to latent heat, water starts to evaporate. As water is evaporated taking heat from the air, the temperature of air decreases. Since the evaporative cooling is based on the heat and mass exchange between air and water, the dry air has greater cooling effect as compared to wet air. Thus, it is more efficient in hot and dry climatic areas but it can also be used in humid areas by incorporating suitable desiccation media. It is more convenient to use than other cooling methods; it requires low energy, easy maintenance, installation, and operation. Evaporative cooling methods which are being used nowadays for greenhouse cultivation are fogging, fan-pad method, and misting**.** This paper is intended to review and discuss how different types of evaporative cooling methods have been utilized for greenhouse cultivation all over the world along with their cooling performances. The paper also reviewed two-stage evaporative cooling technologies, which have been applicable for excessive hot climatic regions like desert climate.

Types of evaporative cooling. There are three main kinds of greenhouse evaporative cooling systems: direct evaporative cooling, indirect or roof evaporative cooling and two-stage or mixed mode cooling systems. The cooling performance of each method depends on the extent to which the dry-bulb temperature of the supplied air exceeds the wet-bulb temperature of the air. In direct evaporative cooling, water is directly applied by suitable mechanical equipment into the air, mostly with water spray or soaked surface. During evaporation, water takes heat from the warm air, thus reducing the amount of the dry bulb temperature. These methods are very common in greenhouses. The schematic diagram is shown in Figure 1.

In indirect evaporative cooling energy exchange occurs between two air streams, separated by a heat exchanging device with a dry-side where only air is being cooled and a wet-side where both air and water are being cooled. In this cooling system, on the dry-side of the heat exchanger, hot primary air is supplied to cool. On the wet-side, secondary air passes over the heat exchanger surfaces, the water evaporates and the surfaces are cooled, the moist secondary air was exhausted to the outside. The schematic diagram is shown in Figure 2.

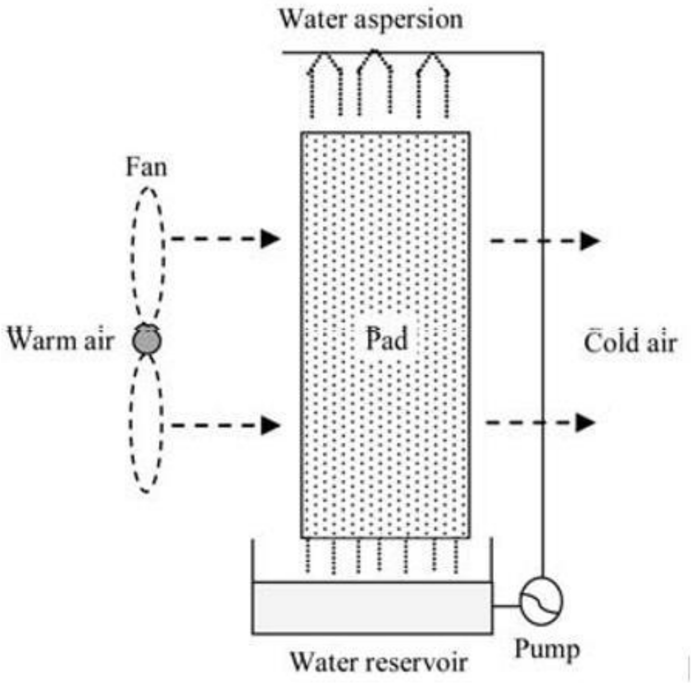

Figure 1. Simplified schematic diagram of direct evaporative cooling system

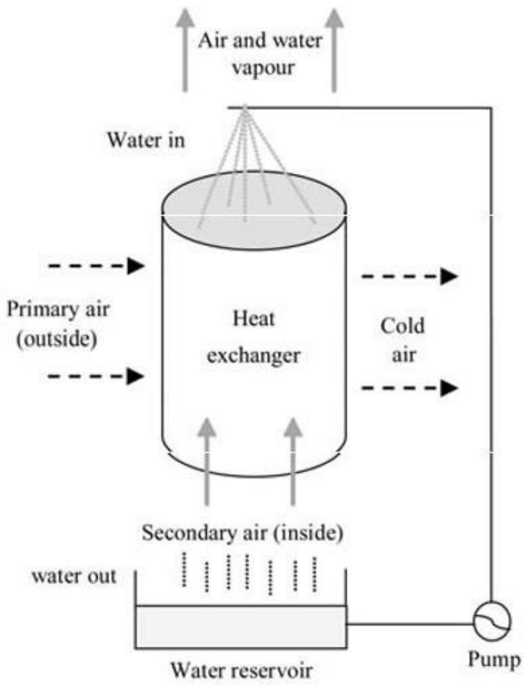

Figure 2. General arrangement of an indirect evaporative cooling system

In two-stage evaporative cooling, a non-mixing type heat exchanger is used in combination with a direct evaporative system. During the first stage of cooling, the incoming air stream passes through a heat exchanger where only sensible cooling takes place and it doesn't pick up any extra moisture. In the second stage of cooling, the same air stream passes through a wetted pad where the additional cooling occurs and the air picks up some moisture which increases the humidity. In the onward sections, a detailed review of the different kinds of evaporative cooling techniques for greenhouse application has been presented. The survey of the literature shows that indirect evaporative cooling alone had not been applied in a greenhouse. Most of the literatures are available in the mixed mode of cooling i.e. in the combination of direct and indirect cooling system.

Direct evaporative cooling. A detailed analysis, as well as literature review related to various kinds of direct evaporative cooling systems on greenhouses application, is presented in this section. 2.1.1 Fan-pad system The fan-pad evaporative cooling has been applied since 1954 and is still the most common system in greenhouses during summer (Purohit, 2012). Fan and pad system is comprised of three main equipment circulation pumps, exhaust fan and evaporative pad. An exhaust fan is fitted on one side of the greenhouse wall while a wetted pad is fitted on the opposite side of the wall. A pump is placed near the pad to circulate water over and through the pad. Warm outside air is drawn through the wetted pad when the fan is in operation and as a result, the warm air loses its heat due to the evaporation of water. So, greenhouse air remains cold. The following section is intended to review the literature related to the fan-pad system in greenhouses. Baily (1968) carried out a general study on a fan-pad evaporative cooling greenhouse.

He mentioned that shredded aspen wood could be utilized as pad material which provides maximum dry bulb depression when air moved with a velocity of 150 feet per minute. The efficiency of such kind of cooling pad was approximately 85%. He suggested some significant concept of fan and pad sizing, installation of the fan-pad system and how to avoid pad clogging. He also mentioned some hazards which may occur in greenhouses cooled by fan-pad evaporative cooling. Jimenez and Casas-Vazquez (1978) did a work related to greenhouse evaporative cooling. They carried out several experiments to modify the microclimate of a glasshouse in hot summer. The glasshouse was built on the aluminum frame and fitted with two fan-induced ventilators and a water curtain made by three perforated plastic tubes. The first perforated plastic tube was placed at the entrance of the house to cool greenhouse air whenever ventilators draw air through it; the second perforated plastic tube was placed on the roof for roof cooling by intermittent or continuous irrigation; the third plastic tube was placed at the centre for irrigation and to reduce the ground temperature. They concluded that recorded temperatures at the micrometeorological inside of the glasshouse could be maintained same to recorded temperatures at the micrometeorological screen outside the house in summer. Landsberg et al. (1979) theoretically investigated that how much cooling could be possible in a glasshouse with single-stage evaporative cooling. Analysis revealed that by using evaporative cooling methods greenhouse air temperature was 8ºC-12ºC below the outside air temperature though outside radiations were very high.

The cooling effect was observed by Chandra et al. (1989) on a fan-pad greenhouse. They used Landsberg's model for computing the greenhouse air temperature and reported that temperature was stayed in between 4ºC-5ºC below the outside air. Jamal (1994) investigated a performance study on a commercial greenhouse in a hot area with a pad-fan system. He determined that the amount of cooling required was depended on the rate of air volume flowed through the pad (i.e. air changes per hour; ACH). It was found that 20 ACH was sufficient to provide a suitable microclimate during hot and dry conditions. They also determined the amount of water required for the evaporative cooling system. The water evaporation and air flow rate were computed by Abdel-Wahab (1994) for different farm structures having an evaporative cooling system. They developed a thermal model by taking energy (heat and mass) balance equations of the farm structures. The model had been validated using a multi-span fan-pad ventilated greenhouse located in a hot and dry climatic condition (Saudi Arabia). It was observed that when the cooling efficiency increased, both the rate of water evaporation and flow rate of air decreased. They suggested that with external shading and improvement of cooling efficiency provided a better result for saving energy and water requirement. Jain and Tiwari (2002) developed a thermal model for an even-span greenhouse fitted with cellulose pad and fan and compared the results of the model with experimental data. From their model, they calculated the thermal load level inside the greenhouse for composite Indian climatic regions. They found that inside air temperature of the greenhouse was 4ºC-5ºC lower than that of the outside.

The cooling system parameters (like length, height, air mass flow rate and cooling pad area) were optimized against the peak temperature and thermal load leveling in different zones of the greenhouse. The temperature variation inside a long (60 m) and multi-span partially shaded greenhouse with fan-pad arrangement studied by Bartzanas and Kittas (2005). They observed that the pad end temperature was 10°C less than the ambient air temperature when the ambient climatic condition was hot and dry. It was also observed that fan end temperature was 8°C higher than pad end temperature as air moved through a long path. They reported that pad end to fan end i.e. along the length of the greenhouse there was non-uniform climatic variations. Radhwan and Fath (2005) presented an integrated greenhouse system in combination with solar distillation and evaporative cooler in Saudi Arabia. The greenhouse roof was fitted with a set of solar basins to reduce greenhouse cooling load as well as to produce fresh water. During summer, the greenhouse was cooled by the evaporative cooler with a forced blower. It was found that on a hot summer day, the greenhouse inside temperature could be reduced 8ºC -10ºC at the inlet and 3ºC-6ºC at the outlet of the greenhouse than that of ambient. Fuchs et al. (2006) revealed a technique to determine latent heat cooling using the crop transpiration and evaporation of water in a fan- pad evaporative cooling greenhouse.

Their technique was capable of predicting crop transpiration, the temperature of foliage and the inner climate. They reported that cooling took place if the ambient relative humidity and air temperature were below 50% and 35ºC respectively. They concluded that greenhouse temperature and the rate of crop transpiration with the wet pad was not dependent on external factors. Al-Heelal et al. (2006) carried out a performance study on an evaporative cooling greenhouse comprised of fan-pad system and photovoltaic power system under extreme summer conditions. They emphasized on the pad clogging which occurred as a result of salt deposition, reduced the pad effectiveness significantly. They observed that when pad clogging occurred, greenhouse air temperature was increased up to 55ºC and relative humidity inside the greenhouse was decreased up to 8%.

Pad clogging also decreased the proper yield of plants. It was also found that power consumption was highly influenced by the ambient temperature. Sukla et al. (2006) carried an experiment in a cascade greenhouse having fan-pad evaporative cooling with thermal curtain placed inside to restrict incoming solar radiation to reduce greenhouse air temperature. In their greenhouse, they also considered an earth to air heat exchanger to provide a better cooling effect. It was found that during a hot summer day, the inside temperature of the greenhouse could be reduced 5ºC -8ºC than the outside air temperature by employing combined cooling systems.

Ganguly and Ghosh (2007) developed a simplified model for a fan-pad ventilated greenhouse system. The model was built considering the total greenhouse structure as a single element and energy exchange occurred on that element. They compared the results of the thermal model with a reference study of literature.

They found that a temperature reduction of 6ºC was attained with 75% shading screen placed inside the greenhouse during a hot summer in Kolkata. Max et al. (2009) conducted experiments during a dry season in four east–west oriented tomato cultivated greenhouses. The two greenhouses with net covered vents were fan ventilated, while the other two were fully plastic covered having a fan-pad evaporative cooling system. Authors had made a comparative study between these two sets of the greenhouses in terms of temperature reduction, crop vapour pressure deficit, crop water consumption and crop yield. It was found that mean temperature variations between two kinds of greenhouses during a day and night period was 2.6ºC and 1.2ºC respectively. Ahmed et al. (2011) mentioned off seasonal cultivation of crop inside the greenhouses by maintaining a suitable evaporative cooling system. They carried out experiments using three different kinds of pads; straw pads, celdek pads, and sliced wood pads. They observed that no significant variation between the inner and outside air temperature of the greenhouse was found in the morning while significant differences were found at noon and afternoon periods.

The differences in relative humidity were highly significant in between 8 am and 1 pm. The saturation efficiency was dependent on cooling pad materials; highest saturation efficiency was given by sliced wood pads while straw pads gave the lowest. Lo´pez et al. (2012) investigated the characteristic of air flow by using sonic anemometry for two distinct greenhouses with evaporative cooling systems. They selected a greenhouse equipped with a fan-pad cooling system and a low-pressure water/air fog cooled greenhouse for the study. It was found that the pad-fan system with shading screen was able to maintain more suitable conditions than the fog system. They found that in an empty greenhouse fan-pad system reduced the inner air temperature by 11.6ºC lower than the naturally ventilated one while fog system reduced the temperature up to 10.4ºC. Alghannam (2012) conducted several studies to determine the efficiency of several control systems incorporated in a pad-fan cooled greenhouse.

He carried out five different tests, Proportional Controller Test (P), Proportional- Integral Controller Test (PI), Proportional Derivative Controller Test (PD), Proportional Integral Derivative Controller Test (PID) and Fuzzy Logic Controller (FLC). All the tests were accomplished to cool the greenhouse from 40°C to 25°C in the extreme summer conditions. He had compared the five control systems theoretically and experimentally. To check the temperature gradient along the length of a conventional fan-pad greenhouse, Misra and Ghosh (2013) proposed longitudinally placed pads with ridge ventilated system. In their greenhouse system, the induced draught fans were fitted at the top of the roof, while the cooling pads were fitted on the sidewalls, as shown in Figure 3. They established a thermal model to predict the inner temperatures considering the energy balance of the greenhouse components. The model results had been validated with a contemporary literature. They reported that temperature in the plantation zone was decreased by 5ºC-7ºC below the ambient temperature providing 1.2 ACM ventilation rate and 50% canopy shading during summer in Kolkata. Chen et al. (2014) presented a CFD simulation for a greenhouse and validated it with an experimental greenhouse equipped with the external and internal shading screens and fan-pad evaporative cooling system. They found a healthy match between the simulated and measured values.

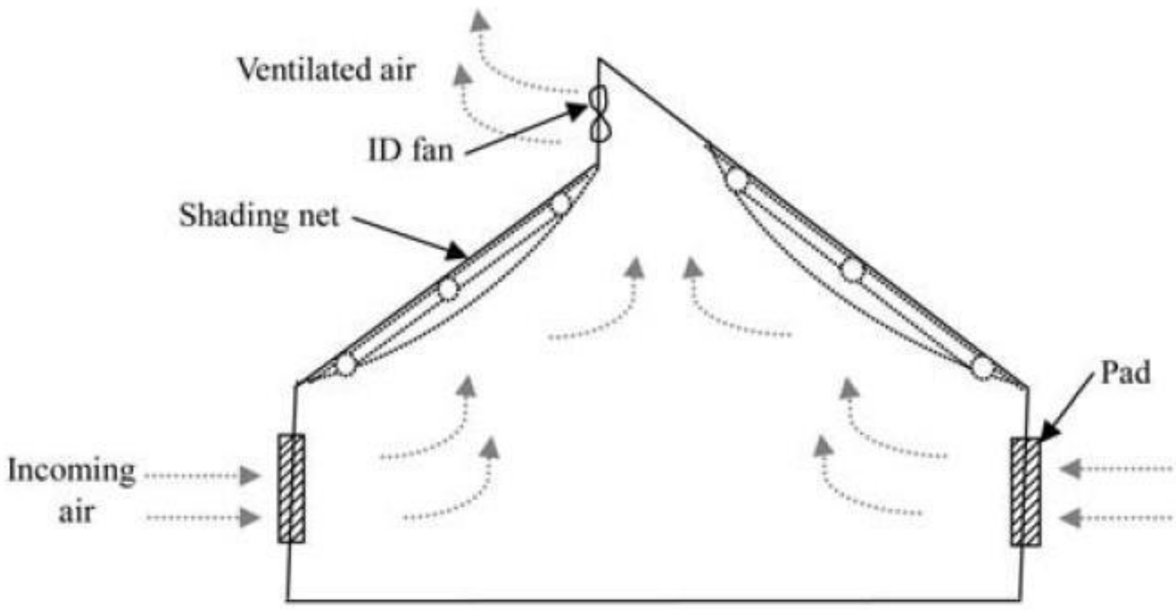

Figure 3. Longitudinal evaporative cooled greenhouse; sectional side elevation (Misra and Ghosh, 2013)

The variations of measured and simulated results were 0.9ºC to 3ºC and less than 0.15 m s-1 in terms of temperature and velocity respectively. They also suggested what should be the location of pad or fan for the optimum cooling effect of the crop. Lengthwise climatic parameters of a fan-pad cooled greenhouse were studied by Ali Dayioglu (2015). He measured the internal and external climatic parameters. It was observed that the temperature variations along the length were not uniform while humidity variations remained approximately constant due to the crop transpiration. The results showed that approximately 7ºC temperature variation occurred between pad end and fan end. The hourly average cooling effect and cooling efficiency was found to be 6.96ºC and 76.8% respectively. Xu et al. (2015) investigated the thermal environment of a fan-pad greenhouse with thermal screens or external shade and air circulatory fans in a humid subtropical climate.

Finally, they concluded that under high RH condition, inside air could be kept in between 27ºC-29ºC while using both the cooling pad and shading the inner air temperature could be maintained 2ºC-3ºC below the outside air temperature with 80% relative humidity. Thipe et al. (2017) reviewed the effect of naturally ventilated system and fan-pad system in crop growth for the greenhouse in arid climatic regions. They summarized that the internal microclimate of the greenhouse could be controlled by side or roof vents in natural ventilation or by using fan-pad arrangement. They stated that natural ventilation showed poor performance for reducing the thermal load in arid or semi-arid regions.

On the other hand, fan-pad system is not so effective in sub-humid regions. They also stated that fan-pad ventilation showed better result than natural ventilation in Southern African regions, while in the tropical and Mediterranean climates, natural ventilation performed better. The energy required by fan-pad systems for the cooling process incorporating photovoltaic system in greenhouses had been calculated by Romantchik et al. (2017). They developed a mathematical model that predicted the greenhouse temperatures and ventilation rates which was calibrated with experimental data. It was observed that mathematical model was reliable enough to supply the energy requirement for the cooling process in a hot summer day. They finally concluded that in order to design any photovoltaic system it was mandatory to determine appropriate ventilation rate created by fan power. Misra and Ghosh (2017a) carried out a performance study of a greenhouse system surrounded by shallow water ponds and floating wetted surfaces under dual ventilation mode. They predicted the greenhouse temperatures using thermal models with or without evaporative cooling under natural ventilation as well as fan-induced ventilation.

They reported that greenhouse temperature could be reduced by 3ºC-6ºC lower than that of the ambient temperature under dual ventilation mode when saturation efficiency and shading were 70% and 75% respectively. 2.1.2 Fogging system Fogging system is based on spraying water into the air stream as fine droplets (in the range of 2-60 μm in diameter) in which direct contact with water in the air takes place. The size of the fine droplet is beneficial since it disperses into the air quickly and evaporates early before they fall on plant foliage. The key feature of the fogging system is high water evaporation rate though it creates high humidity. In this section literature related to the fogging system is reviewed and presented. Montero and Anton (1990) examined that fine fog generation with the use of air and water could moderate the greenhouse microclimate. They used twin fluid nozzles provided for supplying compressed air as well as water at 300-600 kPa pressure and similar flow rates which were mixed in order to produce dense fog.

Two multi-arched greenhouses were considered with 45% radiation transmitting shading where total 26 fog nozzles were fitted. It was observed that 3ºC temperature difference could be achieved by fog cooling compared un-fogged greenhouse. Luchow and Von Zabeltitz (1992) carried out an experiment on greenhouse cooling system for arid climatic regions. They examined the overall performance of the greenhouse considering the temperature and RH of the entering air, exchange of heat between inside air and water spray and the pressure of the nozzles. They found that counter current flow between air and water stream was provided about 100% heat exchanging efficiency. It was also found that optimum results were achieved when the pressure of the nozzle was 21.05 bar and a water/air coefficient was 0.09 kg of water per kg air. Boulard (1993) developed a fog evaporative cooling model for a naturally ventilated greenhouse to explain a complex iteration between aeration and water spray effect on greenhouse cooling.

The model computed greenhouse temperature, humidity of the air, and the plant foliage temperature and plant transpiration. The results of computed values showed a good agreement with measured data. Montero et al. (1994) developed a comparative performance study between fog-cooled greenhouse and un-cooled greenhouse. They considered air water fogging system with 45% transmissivity of shading screen during sunny days. Maximum temperature reduction was observed 5ºC as compared to the un-cooled greenhouse. Hayashi et al. (1998) measured the temperature and humidity inside a three-span glasshouse with fully open ridge vent and a sliding door type vent of a fog-cooled greenhouse. The fog water was sprayed intermittently by the fog-nozzle placed at 2 m above the floor level.

They observed that the inside temperature was lowered by 4ºC-8ºC and greenhouse temperature approached to wet bulb temperature within 1 min after fogging started. Arbel et al. (1999) developed a thermal model of a fog cooled greenhouse system. They conducted an experiment in a four-span greenhouse which was equally divided into two parts. Each part of the greenhouse was equipped with fog system as well as with fan-pad evaporative cooling system. They did a comparative study by operating each cooling system in the two parts alternately and reported that fog cooling system performed better than the fan-pad evaporative cooling system. The misting effect on the inside air and plant in a rose crop greenhouse was examined by Katsoulas et al. (2001). They estimated that only 40%-50% of the mist water could be effectively utilized for evaporative cooling. They calculated crop water stress index and reported that crop was less stressed under misting conditions. In another work, Arbel et al. (2003) presented a cooling arrangement for a greenhouse combined with high pressure fogging and fan-induced ventilation system. It was stated that with such type of cooling arrangement the temperature and relative humidity was 28ºC and 80% respectively during mid-summer.

Öztürk (2003) carried out an experiment in a multi-span fog-cooled plastic greenhouse to determine the fogging system efficiency. They reported that the fogging system had reduced the inner greenhouse temperature around 6.6ºC than the ambient air temperature. The average fogging system efficiency was 50.5%. Handarto et al. (2006) investigated the dry bulb temperature, relative humidity, plant temperature and cooling efficiency for a single span greenhouse with the fogging system during a mid-summer day in Japan.

During the experimental observation, side-walls and continuous roof ventilators of the greenhouse were fully open. They found that during the experiment, the fogging system could lower the inside dry bulb temperature (Tidb) 6°C below the outside temperature. It was observed that during the fogging time period, Tidb was mostly the same as Tleaf (leaf temperature) and during the interval periods, Tidb increased while Tleaf remained unchanged. Cooling efficiency was found to be in-between 57%-80%. Ahmed et al. (2006) established a dynamic model for a fog cooled greenhouse under natural ventilation. The developed model predicted the greenhouse air temperature, plant temperature, cover temperature, floor surface temperature, relative humidity, transpiration, and evaporation rate. The model results have been compared with an experimental greenhouse installed in Tokyo.

Abdel-Ghany et al. (2006) suggested a new definition of cooling efficiency for a fog-cooled greenhouse system. They investigated the cooling efficiencies for different fogging cycles. The expression was derived from mass and energy balance of warm (un-cooled) air inside the greenhouse. They had also shown that the increasing evaporation rate decreased the air temperature thus increased the cooling efficiency. Ishii et al. (2006) investigated the ventilation effect on plant microenvironment and the use of water (cooling and plant transpiration) in a semiarid fog-cooled greenhouse system. Experiments were conducted considering two combinations of roof and side vents. They found that in natural ventilation fog cooling method was capable of maintaining the greenhouse inside temperature within 23ºC-26ºC for the both vent cases. They reported that while the relative humidity increased, the ventilation rate and water requirement in the greenhouse was decreased.

A comparative study between a low pressure (4.05 bar) fogging system and high pressure (40.5 bar) fogging system was studied by Willits et al. (2008). They observed that high-pressure fogging system provided the better cooling than low-pressure systems. A comparative study relating to cooling and evaporation effectiveness also had been shown in this work. In another work, Katsoulas et al. (2006) carried out a study to identify the effect of fogging in greenhouse microclimate for soilless pepper crop production. They studied the humidity control influence on greenhouse environment, the rate of crop transpiration and yield and fruit quality of the crop. They found that compared to no-fogging, greenhouse air temperature and plant leaf temperature were about 3ºC lower in fog cooled condition. Again, Katsoulas et al. (2009) studied the effect of high pressure fogging in greenhouse microclimate where eggplants were cultivated.

Measurements were carried out dividing the whole greenhouse into two compartments; one compartment involved natural ventilation and another one was with fog cooling system. It was examined that temperature of the fog-cooled compartment was dropped by 2.5ºC-3.5ºC in comparison with the other naturally cooled compartment. The fog cooling lowered the average fruit temperature around 3°C and kept greenhouse temperature below 32°C. Garcia et al. (2011) investigated the efficiency of two cooling methods, employing external movable shading and spraying fog water in a plastic covered greenhouse in Mediterranean region. They conducted several experiments considering different settings of shading to restrict the solar radiation falling into the greenhouse. They investigated that as compared to fixed shading, cooling efficiencies were likely similar for all the cases. Linker et al. (2011) developed a robust control approach to maintaining the expected inner environment in a small greenhouse fitted with a variable flow rate high pressure fog nozzles and variable-speed extracting fans. The controllers were designed by the quantitative feedback theory (QFT), which sustained suitable performance. Sánchez-Hermosilla et al. (2013) carried out a comparative study between a fog-cooled system and cooling with a conventional spray-gun in a greenhouse.

The total greenhouse was divided into two modules, one for the spray-gun system and another for the fogging system. They reported using spray gun the crop deposition values were far less than that of using the fog system. Ishigami et al. (2014) experimented on two separate fog- cooled greenhouses, each having 26.4 m2 floor areas. They observed that twin fluid nozzle system had higher evaporation rate and lower degree of wetting of plant foliage as compared to single fluid nozzle system. It was observed that twin fluid nozzle system produced the same cooling effect as single fluid nozzle system.

Yasutake et al. (2014) designed and developed a fogging and circulation system into a greenhouse to control daytime humidity and airflow. The cooling system composed of nine mist sprayers and two fans of diameter 0.3 m each. They found that fogging and circulation systems could improve the greenhouse microclimate during the daytime. White (2015) presented a cooling system comprised of vent, fan, and fog (VFF) for a large (72 m wide × 139.5 m long) Velno greenhouse that could effectively cool the greenhouse environment in hot and dry seasons. The greenhouse was shaded by 61% shading screen and fitted with high pressure fog nozzles. There were eighteen exhaust fans, nine in each of the north and south gable ends walls while others were placed on the concrete nib walls, close to ground level. The fans provided a nominal air flow of 0.0188 m3 s-1 m-2.

It was reported that in such kind of cooling arrangements, the inside temperature of the greenhouse could be lowered in the range of 5.8ºC to 10.8°C with a mean of 9°C cooling at the time of maximum greenhouse temperature and 10ºC to 14.9°C with a mean of 12°C cooling at the time of the ambient maximum. Misra and Ghosh (2017b) developed a simplified thermal model for a fog-cooled greenhouse operating under natural ventilation and validated the model with an experimental arched shape plastic greenhouse situated in eastern Indian. They observed that greenhouse inside temperature solely depends on fogging configurations and found that optimum fogging cycle when spray time to interval time was 1.5-2.0 min. The schematic diagram is shown in Figure 4. Finally, they concluded that with the low pressure fogging system with suitable ventilation greenhouse inside temperature could be maintained 2ºC-4°C lower than the ambient temperature.

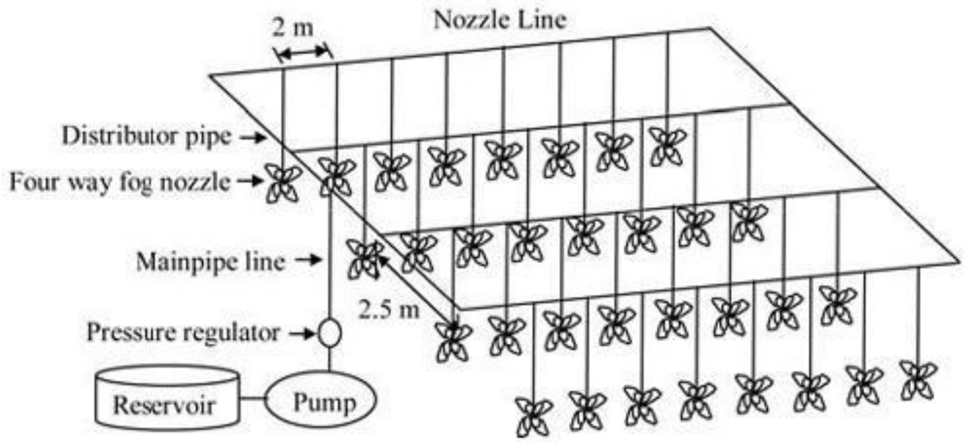

Figure 4. Schematic diagram of fogging system components (Misra et al., 2017)

Indirect or roof evaporative cooling. Roof evaporative cooling is one of the simple methods of evaporative cooling systems. In this cooling system, cooling is achieved by spraying water on the roof of the greenhouse. The water evaporates taking heat from roof and cools the roof surface Sutar and Tiwari (1995) conducted a study to understand the effect of roof cooling on greenhouse environment. They selected a plastic greenhouse covered with a wet cloth (water film) in Delhi. They found that the inner air temperature was decreased by 4ºC-5ºC than the controlled greenhouse. It was also found that with wet roof cloth of the greenhouse, the inner air temperature was decreased about 10ºC. Morris et al. (1958) observed that by sprinkling water on the roof of a glasshouse, the solar radiation transmissivity was decreased by 6%. It also lowered the inside air temperature by lowering the temperature of the glass surface. Cohen et al. (1983) carried out a study in glasshouses providing water on roof surface and misting on plant foliage and soil surfaces.

They intended to find the temperature of inner air and the surface of the glasshouse. The experiments were conducted when ambient solar radiation was high. It was investigated that roof cooling was not so much effective in lowering the greenhouse and plant foliage temperatures than misting on the plant foliage and soil surface. With the combined evaporative cooling of roof as well as plant foliage and soil surface, greenhouse temperature could be reduced by nearly 5ºC and plant foliage temperature was reduced by around 7ºC than the ambient temperature. Giacomelli et al. (1985) conducted two types of cooling system, a wetted over headed energy saving blanket and fog nozzle on a movable boom system. The blanket was wetted by mist nozzle and placed at greenhouse attic. The temperature reduction was observed 4ºC by wetted blanket system and 10ºC reduction was observed by fog nozzle on a movable boom system. Sutar and Tiwari (1995) analyzed the different conditions of evaporative cooling for controlled environment agriculture (CEA) system. The proposed CEA system was designed for a low-cost polyethylene covered even span greenhouse having 20 m2 of floor area with a provision of roof cooling by water.

They reported that with water sprinkling over the roof and wall of the CEA system, enclosure temperature could be achieved even lower than the plant temperature. Willits and Peet (2000) examined the cooling performance of a greenhouse covering by flat-woven poly-propylene shade. The observations were accomplished maintaining the shade cloth both in wetted and dried conditions accordingly. The experiment was conducted by supplying of water on the roof shade cloth and observed that the inside temperature was decreased by 41% using wet cloth than that of dry cloth where this reduction was 18%. Willit (2001) studied out the utilization of shade cloths on greenhouse roof to reduce the temperature of a greenhouse both in dry and wet conditions. They considered four kinds of shade cloths for their examination. It was observed that heavier shade cloths under wetted condition provided better cooling.

Ghosal et al. (2003) presented a roof evaporative cooling model considering thin film of water on roof surface in an even span greenhouse. They validated their model with an experimental greenhouse located in Delhi. The experiments were conducted under three distinct conditions of the greenhouse; shading with water sprinkling on roof, roof shading and roof un-shading conditions. It was observed that the greenhouse temperature was decreased by 6ºC and 2oC in shading with water sprinkling and shading without flow of water conditions respectively in comparison to un-shading conditions. The schematic diagram is shown in Figure 5.

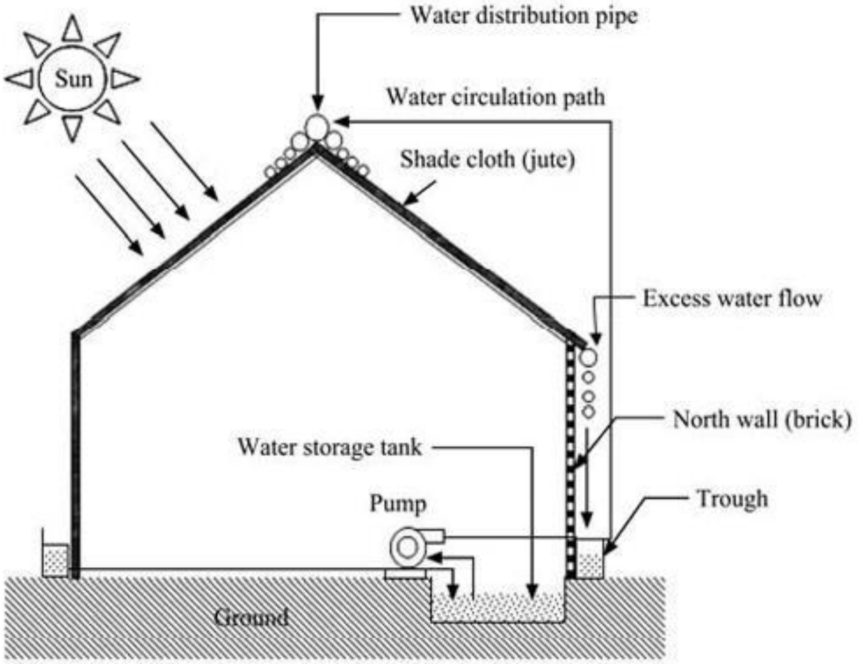

Figure 5. Schematic diagram of a greenhouse with wetted roof shade cloth (Ghosal et al., 2003)

Ghosal and Das (2012) presented a mathematical model of an even span greenhouse in which roof cooling was done by a film of moving water. Thin film of water flow on roof was maintained by jute cloth stretched on the roofs of greenhouse. The developed model was capable of investigating the effectiveness of cooling system. Helmy et al. (2013) carried out an experimental study on two small (6 m2) identical greenhouses with combined evaporative cooling system on roof as well as interior. It was revealed that the combined cooling system provided better performance than the fan-pad system and nearly 1.1ºC-5.44ºC temperature difference existed between these two systems in the morning and afternoon respectively. They had experimented on various kinds of pad materials to search best pad material in terms of cooling efficiency.

Two-stage evaporative and mixed mode cooling. In this section, literature related to combined or mixed mode cooling as well as the two-stage evaporative cooling system are presented. Bailey (1998) presented a greenhouse system which could be used to produce suitable microclimate for plant production as well as to provide irrigation water for coastal greenhouses. Their model simulation showed that greenhouse temperature could be reduced to 4.1ºC than ambient and yearly water production was 900 kg m-2 of the greenhouse when condenser cooling water was 3ºC lower than surface seawater. Sablani et al. (2003) carried out a study based on thermodynamic simulation of a seawater greenhouse. The seawater greenhouse system is shown in Figure 6. They reported that seawater greenhouse was an important way for crop growth as well as for the generation of fresh water in hot and arid regions. In their greenhouse system, a small stream of seawater had fallen into a porous evaporator and the air was drawn by the fan to cool the air. The greenhouse roof material had received selected radiations which were utilized for plant photosynthesis as well as to keep the greenhouse cool. The air was again supplied to a second evaporator it further gained moisture and became saturated. The saturated air moved through the condenser, which was cooled by deep cold seawater. The saturated air condensed at the condenser and freshwater was generated.

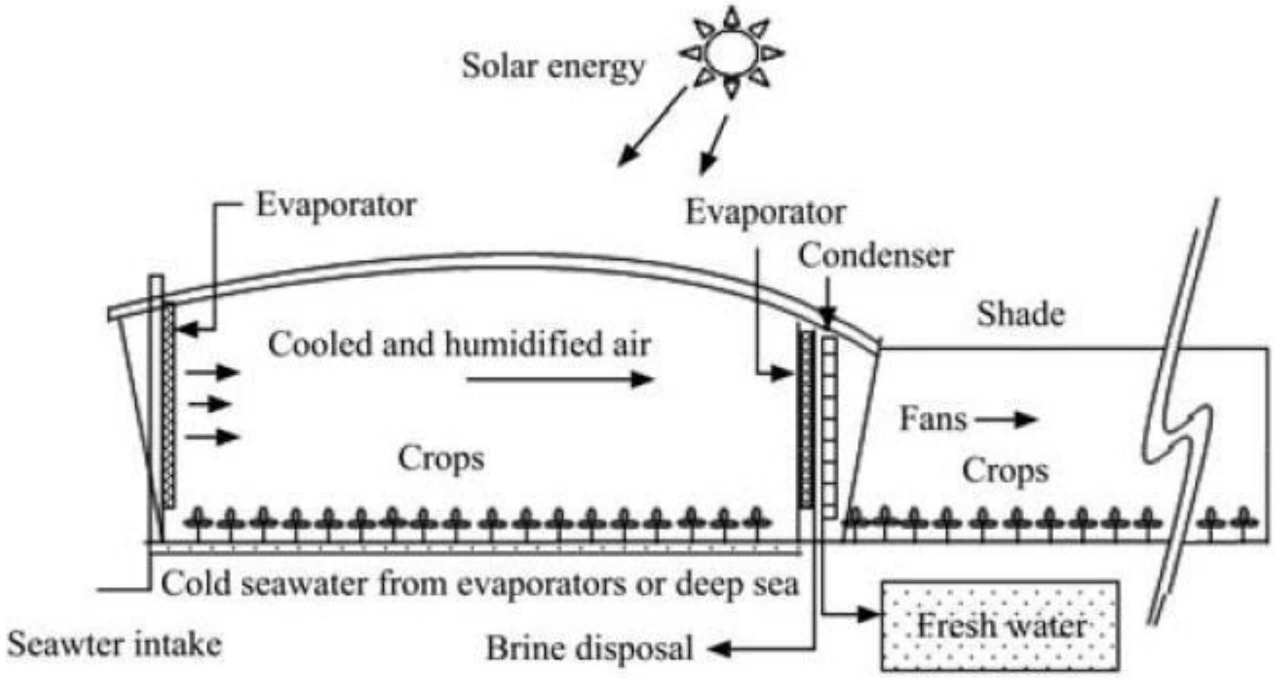

Figure 6 Seawater greenhouse system (Sablani et al., 2003)

Perret et al. (2005) presented a Quonset greenhouse, where humidification and dehumidification systems were suitably designed. The greenhouse was equipped with two humidifiers that were used to reduce temperature and raise relative humidity of the air and two dehumidifiers (i.e. condensers) which condensed the water vapour to reduce the temperature of the air below its dew-point. Davies and Paton (2005) presented a CFD model and calibrated with a prototype seawater greenhouse constructed in UAE. The schematic diagram is shown in Figure 7. The model calibration could be able to predict the inside temperatures and airflow. According to Davies (2005) liquid desiccators along with solar regeneration can be regarded for lowering the temperature of an evaporatively cooled greenhouse. He proposed a scheme similar to a traditional fan-pad system along with a desiccant pad fitted prior to the first evaporator pad. He undertook an experiment in the Gulf climate in Abu Dhabi and reported that liquid-desiccant cooling system could lower the greenhouse temperature by 5ºC than that of the traditional fan-pad system. Mahmoudi et al. (2010) established a model using a passive condenser for the improvement of fresh water generation.

The greenhouse provided a cold climate to the plants. The simulated results showed that the passive condenser had a higher capability to produce fresh water than the actual pump operated system. Wong et al. (2011) develop a conceptual design of the mechanical equipment required to cool, store heat, and heat a greenhouse operation, employing aquifer thermal energy storage (ATES) system. They developed a detail thermal energy model using TRNSYS software for a greenhouse that is capable of simulating the energy performance for both the traditional (open) and the “closed” greenhouse energy operation in the Canadian climate. Abbouda and Almuhanna (2012) designed a two-stage evaporative cooling system comprising of a direct evaporative cooling (DEC) consisting of the cooling pad and indirect cooling consisting of the cooling coils unit (CCU) for greenhouse application. In the DEC heat is absorbed during the evaporation of supplied water, whereas in the CCU heat load of the hot air was transferred while passing through the cooling coil. It was found the CCU could provide the only hourly average temperature drop of 8.1ºC, with the effectiveness of 47.4%. On the other hand, the DEC had an hourly average effectiveness of 75.12%. Again, in the combined cooling mode (both CCU and DEC), the hourly mean greenhouse air temperature was reduced by 19.1ºC during daytime and 9.0ºC at night. Lychnos and Davies (2012) carried out a theoretical model to investigate the performance study of a greenhouse coupled with solar power regenerator, MgCl2 desiccators, and an evaporative pad. The model had been developed for both the regenerator and the desiccators and its results showed healthy match with the experimental values conducted in hot summer. They reported that compared to the traditional evaporative cooling system, the desiccators with pad system reduced the average daily maximum temperatures by 5.5ºC-7.5ºC in the hot season.

Al-Busaidi and Al-Mulla (2014) carried out the experimental investigation on two different greenhouses, seawater greenhouse (SWGH) and conventional greenhouse (CGH) in an arid region in Oman. Both the greenhouses equipped with fans and pad evaporative cooling system but SWGH utilized seawater instead of fresh water for the cooling requirement. Besides, the cooling SWGH included desalination unit to produce fresh water for irrigation needs of cucumber planted inside the greenhouse. It was observed that SWGH reduced the greenhouse temperature 4.8°C while conventional greenhouse reduced the temperature 7.4°C than the ambient. It was also observed that most of the time CGH could not maintain the inside humidity above than 60% whereas SWGH could. Abu-Hamdeh et al. (2016) designed and developed a solar desiccant evaporative cooling system that could be able to cool the greenhouse in high humid climatic regions. They investigated that the proposed cooling could reduce the inside temperature close to 6ºC compared to traditional water evaporation cooling.

Aljubury et al. (2017) presented a two-stage evaporative cooling system (indirect-direct cooling system; IDEC) for protecting plants inside a greenhouse located in the desert climate where the temperature of ambient air frequently reaches to 50ºC. The cooling system comprised of one indirect evaporative cooling (IEC) heat exchanger and three pads divided into three stages. They designed the indirect-direct evaporative cooling (IDEC) system to investigate the greenhouse microclimate. Geothermal water was used as a cooling fluid of indirect heat exchanger as well as for wetting pads. They found that the IDEC system had been raised evaporative cooling efficiency to 108% compared to the direct evaporative cooling (DEC) efficiency which was 77.5%. Finally, they concluded that the IDEC with ground water as a coolant had been deceased greenhouse temperature nearly 12.1ºC to 21.6ºC and increased relative humidity from 8% to 62% compared to the ambient conditions. Banik and Ganguly (2017) developed a thermal model of a desiccant assisted distributed fan-pad ventilated greenhouse system to predict the inside air temperature. They validated the model with a reference model study available in the literature. It was found that in a hot and humid season the greenhouse could be capable of reducing 4.3ºC than ambient whereas conventional fan-pad system did 2.5ºC below the ambient. They also included a cumulative cash flow model to observe the payback period and the Net Present Value of the greenhouse system.

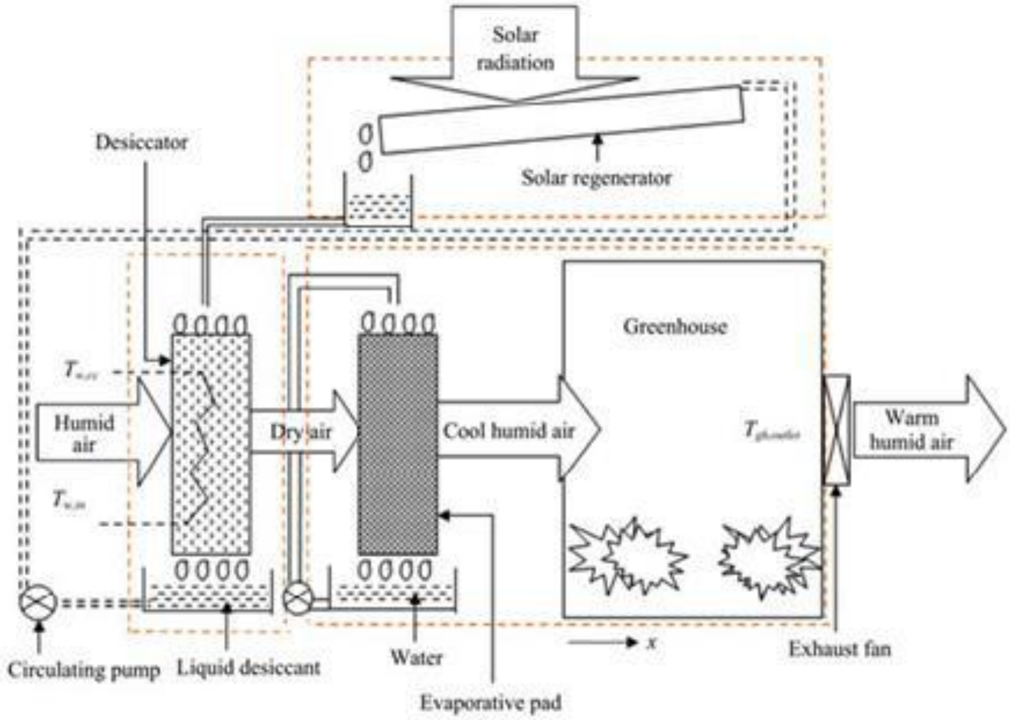

Figure 7. Schematic diagram of evaporative cooled greenhouse system with the solar assisted liquid desiccant pad (Davies, 2005)

Summary and conclusion. The current paper is intended to review the researches of various researchers in the form of theoretical and experimental studies in connection with evaporative cooling systems of greenhouses. The study has been concentrated on fan-pad cooling, fog cooling, roof cooling as well as some promising cooling systems like desiccated pad evaporative cooling, two-stage evaporative cooling, and seawater greenhouses. The work emphasized on the key issues of evaporative cooling and performance features of the systems. The study shows that in greenhouses, evaporative cooling is not applied alone but with some form of ventilation and shading as well. There are some advantages and disadvantages of each evaporative cooling system. Selection of appropriate cooling system depends mainly on local environmental condition as well as greenhouse design and construction.

The review shows that the evaporative cooling systems have been continuously redesigned and enhanced depending upon the climatic conditions to achieve better cooling performance. This advancement is based on the development of relevant theory and practice. The researches have been rapidly progressed, which leads to the increasing numbers of published articles in many countries. The evaporative cooling system also has been developed for extremely hot and dry regions (desert climate) and such climatic regions two-stage evaporative cooling is very much effective to provide suitable microclimate inside of a greenhouse than that of direct evaporative cooling. Again, the review has been done on seawater greenhouse where saline water of sea has been used for cooling as well as irrigation. It is observed that the evaporative cooling system has been exhibited as a quite efficient technique for greenhouse cooling.

The survey of literature revealed that, direct evaporative cooling is able to cool the greenhouse environment 2ºC-12ºC lower than that of the ambient, evaporative cooling with desiccation pad reduce the greenhouse temperature in between 4.3ºC-7.5ºC than that of the ambient and two-stage evaporative cooling using geothermal water can effectively cool the greenhouse environment around 8ºC-21.4ºC than the ambient.

Based on the brief survey of literature, it is observed that lots of researches yet to be done relating to indirect and mixed mode (combination of direct and indirect) of evaporative cooling applicable in a greenhouse environment. More scope of further research is still remaining which can be done in the hot and humid tropic and subtropics. After studying the evaporative cooling system, the following fields are recommended for further research for greenhouse applications. - System design and control of photovoltaic evaporative chimney - Design of evaporative cooling system with solar chimney assisted ventilation - Integrated control of the evaporative cooling and the shading screen - Design and development of passive evaporative cooling - System design of regenerative evaporative cooling - Application of renewable energy (solar and geothermal) for direct or indirect evaporative cooling Practical implementation of the above-mentioned concepts in greenhouse application may face lots of challenges which could be the subject of further research.

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САКСОВУЛ УРУҒИНИ ҚАНОТСИЗЛАНТИРИШ ЖАРАЁНИГА ТАЪСИР ҚИЛУВЧИ ОМИЛЛАР

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Аннотация. Ушбу мақолада саксовул уруғини қанотсизлантириш жараёнини яхшилаш учун таъсир қилувчи асосий омиллар таҳлил қилинган. Тадқиқотда чўткали барабандаги чўткалар сони, чўткали барабан ва элак орасидаги тирқиш, ҳамда барабан айланиш тезлиги каби параметрларнинг уруғ қанотсизлантириш самарадорлигига таъсири ўрганилган. Олинган натижалар асосида энг самарали параметрлар аниқланди ва таклиф қилинди.

Таянч сўзлар: саксовул уруғи, қанотсизлантириш, чўткали барабан, айланиш тезлиги, тирқиш кенглиги.

ФАКТОРЫ, ВЛИЯЮЩИЕ НА ПРОЦЕСС ОБЕЗКРЫЛЕНИЯ СЕМЯН САКСАУЛА

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Аннотация. В данной статье проанализированы основные факторы, влияющие на процесс обезкрыления семян саксаула. В исследовании изучено влияние таких параметров, как количество щёток в щёточном барабане, зазор между щёточным барабаном и решётой, а также скорость вращения барабана, на эффективность обезкрыления семян. На основе полученных результатов определены и предложены наиболее оптимальные параметры.

Ключевые слова: семена саксаула, обезкрыление, щёточный барабан, скорость вращения, ширина зазора.

FACTORS AFFECTING THE DEWINGING PROCESS OF SAXAUL SEEDS

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Annotation. This article analyzes the main factors influencing the process of dewinging saxaul seeds. The study examines the effects of parameters such as the number of brushes in the brush

drum, the gap between the brush drum and the sieve, and the rotation speed of the drum on the efficiency of seed dewinging. Based on the obtained results, the most optimal parameters were identified and proposed.

Keywords: saxaul seeds, dewinging, brush drum, rotation speed, gap width.

Кириш. Саксовул – чўл ҳудудларида муҳит барқарорлигини сақлаш, чанг ва қум бўронларини камайтиришда муҳим ўсимлик ҳисобланади. Унинг уруғлари табиатда табиий тарқалиш хусусиятига эга бўлса-да, сунъий кўпайтириш ва қайта тиклаш ишлари қатор муаммоларни келтириб чиқаради. Хусусан, саксовул уруғларининг қанотли тузилмаси уларни экиш ва қайта ишлаш жараёнларини мураккаблаштиради.

Айниқса, Ўзбекистон ва бошқа Марказий Осиё давлатларида чўлларнинг кенгайиши ва экологик муаммоларнинг кучайиши саксовул экиш тадбирларини кенгайтиришни талаб қилмоқда. Шундай шароитда, уруғларни қайта ишлаш ва қанотсизлантириш технологияларини такомиллаштириш долзарб вазифалардан бири ҳисобланади. Механик қанотсизлантириш жараёнини самарали ташкил этиш уруғлардан фойдаланиш даражасини ошириш, экиш жараёнини енгиллаштириш ва чўл ҳудудларини тиклаш жараёнларини тезлаштириш имконини беради [1-5].

Саксовул (Haloxylon) - чўл ҳудудларида учрайдиган, экотизим учун муҳим бўлган ўсимлик тури ҳисобланади. Унинг уруғлари катта тезликда тарқалиши ва тўғри ўсимлик ҳосил қилиши учун қанотли тузилмага эга. Бироқ, бу қанотли тузилма уруғларни машина воситасида қайта ишлаш ва экиш жараёнида мураккаблик туғдиради. Шу сабабли, уруғларни қанотсизлантириш технологияси самарали бўлиши талаб этилади [6-10].

Қанотсизлантириш жараёни механик усуллар ёрдамида амалга оширилади, бунда уруғлар махсус қурилмаларда ишловдан ўтказилади. Бундай ишлов уруғларнинг ҳам бир текис экилишига, ҳам уларнинг ўсимликка айланиш даражаси ошишига ёрдам беради. Ушбу тадқиқот саксовул уруғини қанотсизлантириш жараёнига таъсир қилувчи учта муҳим омилни таҳлил қилади:

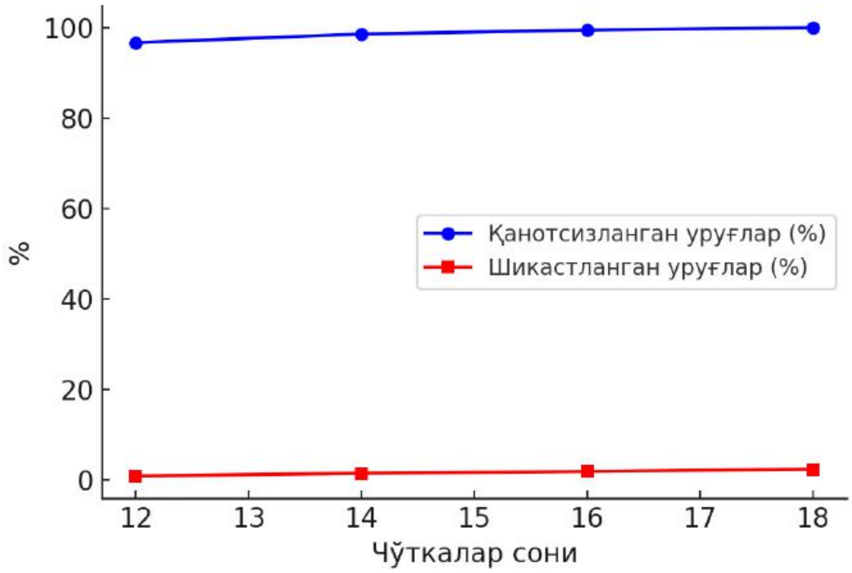
Чўткали барабандаги чўткалар сони – қанотсизлантириш самарадорлиги ва уруғларнинг шикастланиш эҳтимолига таъсир қилади.

Чўткали барабан ва элак орасидаги тирқиш – уруғларни қандай даражада пишиқлик билан ишловдан ўтказиш мумкинлигини белгилайди.

Барабанларнинг айланиш тезлиги – қанотсизлантириш жараёнининг тезлиги ва самарадорлигига таъсир кўрсатади.

Тажриба олиб бориш методикаси. Тажрибалар махсус қанотсизлантирувчи қурилмада олиб борилди. Ушбу қурилма чўткали барабан, элак ва тезликни бошқарувчи механизмдан иборат. Тажриба жараёнида ҳар бир параметр бўйича алоҳида тажрибалар ўтказилиб, натижалар таҳлил қилинди.

Тажриба натижалари. Чўткали барабандаги чўткалар сони боғлиқ ҳолда тажриба олиб борилганда саксовул уруғини қанотсизлантириш жараёнида чўткали барабандаги чўткалар сонининг таъсирини аниқлашга қаратилган. Чўткалар сони ошган сари қанотсизлантириш самарадорлиги ортиб бормоқда, аммо уруғларнинг шикастланиши ҳам бир оз ошмоқда.



1-расм. Чўткали барабандаги чўткалар сонига боғлиқ ҳолда ўзгариши.

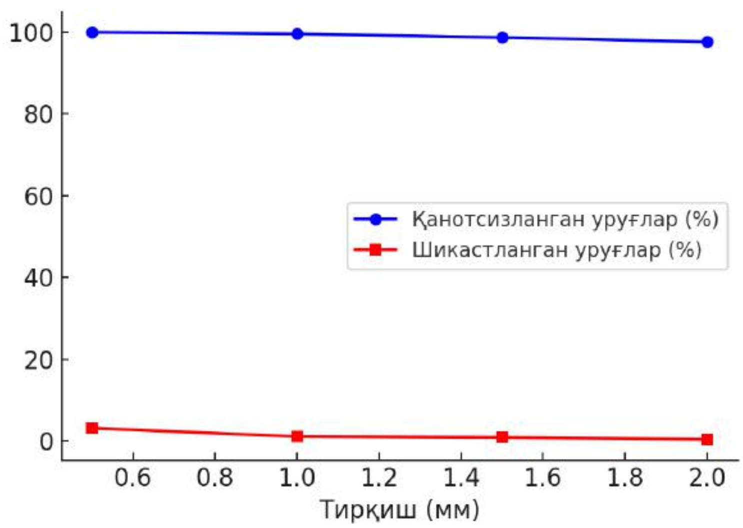
Графикдан кўриниб турибдики, 16-18 та чўткадан фойдаланиш қанотсизлантириш самарадорлигини 99.5-100% гача оширган, бироқ шикастланган уруғлар 2.3% гача кўпайган 1-жадвал.

1-жадвал

Чўткали барабандаги чўткалар сони

Чўткалар сони	Қанотсизланган уруғлар (%)	Шикастланган уруғлар (%)
12	96.7	0.8
14	98.6	1.4
16	99.5	1.8
18	100.0	2.3

Чўткали барабан ва элак орасидаги тирқишни ўрганиш бўйича тажриба олиб борилганда чўткали барабан ва элак орасидаги тирқиш кенглигининг уруғ қанотсизлантириш самарадорлигига таъсирини баҳолашга қаратилган. Тирқиш кенгайган сари шикастланган уруғлар миқдори камайган, аммо қанотсизлантириш самарадорлиги пасайган.



2-расм. Чўткали барабан ва элак орасидаги тирқишга боғлиқ ҳолда ўзгариши.

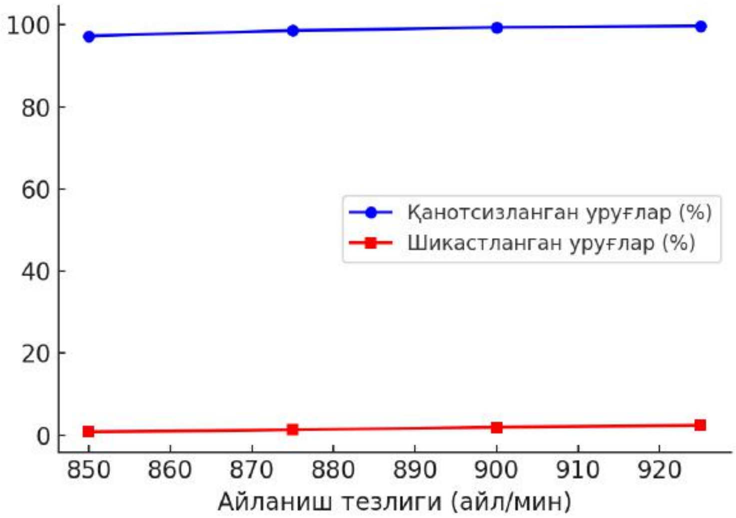
Графикдан кўриниб турибдики, 1.0-1.5 мм тирқиш кенглигида қанотсизлантириш самарадорлиги юқори даражада сақланган, шу билан бирга шикастланган уруғлар 1.1-0.9% атрофида қолган 2-жадвал.

2-жадвал

Чўткали барабан ва элак орасидаги тирқиш

Тирқиш (мм)	Қанотсизланган уруғлар (%)	Шикастланган уруғлар (%)
0.5	100.0	3.2
1.0	99.6	1.1
1.5	98.7	0.9
2.0	97.6	0.4

Сўнги тажрибамизда барабанларнинг айланиш тезлиги ўрганилганда барабанларнинг айланиш тезлигининг уруғ қанотсизлантириш самарадорлиги ва уруғларнинг шикастланишига таъсири ўрганилган. Барабан айланиш тезлиги ошган сари қанотсизлантириш самарадорлиги ҳам ортиб бормоқда, аммо 900 айл/миндан юқорида уруғлар шикастланиш даражаси кескин ошиб бориши кузатилди.



3-расм. Барабанларнинг айланиш тезлигига боғлиқ ҳолда ўзгариши.

График натижаларга асосан, 875-900 айл/мин диапазонида барабан айланиш тезлиги оптимал ҳисобланади, чунки у қанотсизлантириш самарадорлигини 99.4% гача ошириб, уруғларнинг шикастланишини 1.9% даражасида ушлаб туради 3-жадвал.

3-жадвал

Барабанларнинг айланиш тезлиги

Айланиш тезлиги (айл/мин)	Қанотсизланган уруғлар (%)	Шикастланган уруғлар (%)
850	97.3	0.8
875	98.6	1.3
900	99.4	1.9
925	99.7	2.4

Хулоса. Тадқиқот натижаларига кўра, саксовул уруғини қанотсизлантириш самарадорлигига чўткалар сони, тирқиш кенглиги ва барабан айланиш тезлиги катта таъсир кўрсатади. Оптимал натижалар 16-18 та чўтка, 1,0-1,5 мм тирқиш ва 875-900 айл/мин айланиш тезлигида кузатилди. Ушбу параметрлар саксовул уруғини механик қайта ишлаш жараёнини самарали ва кам шикастланадиган ҳолда амалга ошириш имконини беради.

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VINTLI SHNEKNING AYLANISHLAR SONIGA BOG‘LIQ HOLDA OZUQANING YETKAZIB BERISH MIQDORINI O‘ZGARISHI

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Annotatsiya Ushbu maqolada vintli shnek mexanizmlarining aylanishlar soniga bog‘liq holda ozuqaning yetkazib berish miqdorini o‘zgarishi o‘rganildi. Tadqiqot davomida turli aylanish tezliklarida ozuqaning uzatilish bir xilligi va notekisligi baholandi. Olingan natijalarga asosan, 25 ayl/min tezlikda uzatilish bir xilligi eng yuqori darajada (98,7%) ekanligi aniqlandi. Shu bilan birga, yuqori tezliklarda (30 ayl/min) uzatilish notekisligi oshib ketishi qayd etildi. Mazkur tadqiqot natijalari qishloq xo‘jaligi va ozuqa yetkazib berish tizimlarida vintli shneklarni samarali qo‘llash bo‘yicha tavsiyalar ishlab chiqish uchun muhim hisoblanadi.

Tayanch so‘zlar: vintli shnek, ozuqa uzatish, aylanish tezligi, uzatilish bir xilligi, uzatilish notekisligi, qishloq xo‘jaligi mexanizatsiyasi.

ВЛИЯНИЕ КОЛИЧЕСТВА ОБОРОТОВ ВИНТОВОГО ШНЕКА НА ОБЪЕМ ПОДАЧИ КОРМА

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Аннотация. В данной статье изучено влияние количества оборотов винтового шнека на объем подачи корма. В ходе исследования была оценена равномерность и неравномерность подачи корма при различных скоростях вращения. Согласно полученным результатам, на скорости 25 об/мин подача корма была наиболее равномерной (98,7%). Однако при более высокой скорости (30 об/мин) зафиксировано увеличение неравномерности подачи. Результаты данного исследования являются важными для разработки рекомендаций по эффективному использованию винтовых шнеков в сельском хозяйстве и системах подачи кормов.

Ключевые слова: винтовой шнек, подача корма, скорость вращения, равномерность подачи, неравномерность подачи, механизация сельского хозяйства.

THE CHANGE IN THE AMOUNT OF FEED DELIVERY DEPENDING ON THE NUMBER OF ROTATIONS OF THE SCREW AUGER

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Abstract. This article examines the change in the amount of feed delivery depending on the number of rotations of the screw auger. During the study, the uniformity and unevenness of feed delivery at different rotation speeds were evaluated. Based on the obtained results, it was determined that at a speed of 25 rpm, the feed delivery uniformity was at its highest level (98.7%). However, at higher speeds (30 rpm), an increase in delivery unevenness was recorded. The results of this study are important for developing recommendations on the efficient use of screw augers in agriculture and feed delivery systems.

Keywords: screw auger, feed delivery, rotation speed, delivery uniformity, delivery unevenness, agricultural mechanization.

Kirish Qishloq xo‘jaligi mahsulotlarini samarali ishlab chiqarish va chorvachilik sohasida ozuqa ta’minotini yaxshilash bugungi kunda dolzarb masalalardan biri hisoblanadi. Xususan, ozuqaning sifatli va bir xil taqsimlanishi chorva mollarining ozuqa hazm qilish jarayoniga va ularning o‘sish samaradorligiga to‘g‘ridan-to‘g‘ri ta’sir ko‘rsatadi. Bu esa mahsuldorlikni oshirish va ozuqa sarfini tejashga imkon beradi [1-5].

Vintli shneklar ozuqa uzatish mexanizmlarining eng keng tarqalgan turlaridan biri bo‘lib, ularning samaradorligi ozuqaning bir tekisda va ravon uzatilishi bilan belgilanadi. Hozirgi kunda qishloq xo‘jaligida avtomatlashtirilgan ozuqa yetkazib berish tizimlarini joriy etish orqali mehnat unumdorligini oshirish va mahsulot ishlab chiqarish xarajatlarini kamaytirish imkoniyati mavjud. Shu sababli, vintli shnek mexanizmlarining ishlash parametrlarini tadqiq qilish va ularning optimal tezlikda ishlash rejimi aniqlash muhim ahamiyat kasb etadi [6-12].

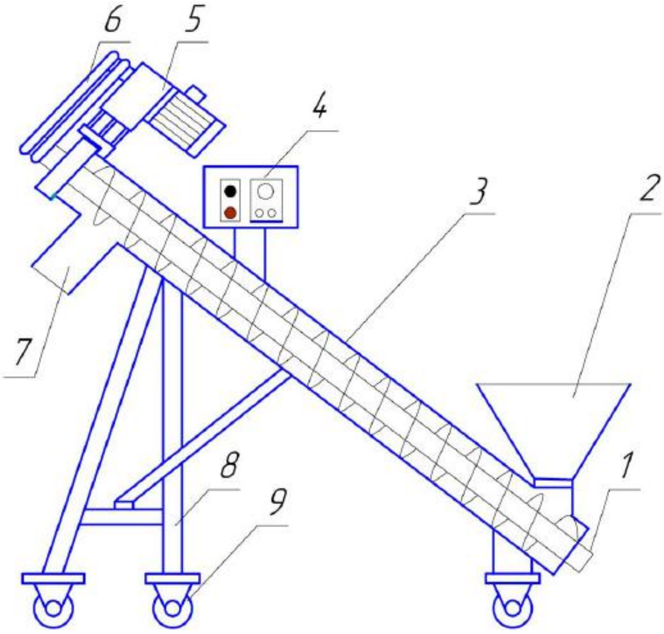
Shu maqsadda, ushbu tadqiqot vintli shnekning aylanish tezligi ozuqa yetkazib berish jarayoniga qanday ta’sir ko‘rsatishini o‘rganishga qaratilgan. Olingan natijalar asosida qishloq xo‘jaligida samarali mexanizatsiya usullarini joriy etish va shnekli transportyorlarning ishlash samaradorligini oshirish bo‘yicha tavsiyalar ishlab chiqiladi.

Materiallar va usullar Tadqiqot davomida turli aylanish sonlarida vintli shnek orqali ozuqa uzatilish bir xilligi va notekisligi o‘lchandi. Bunda laboratoriya sharoitida turli shnek aylanish tezliklarida sinovlar o‘tkazildi. Sinov jarayonida quyidagi jihatlarga e’tibor qaratildi:

Vintli shnekning aylanishlar soni: 15, 20, 25, 30 ayl/min.
Ozuqalarning uzatilish bir xilligi (%);
Ozuqalarning uzatilish notekisligi (%);
Ozuqaning og‘irlik bo‘yicha taqsimlanish koeffisiyenti;
Vintli shnekning konstruktiv parametrlari (chuqurlik, diametri, burchak qismi);
Ozuqaning namligi va uning harakatlanishga ta’siri.

Sinovlar maxsus o‘lchov uskunalari yordamida o‘tkazilib, har bir holatda olingan natijalar tahlil qilindi. Ushbu natijalar asosida ozuqa uzatish jarayonining samaradorligi baholandi va vintli shnekning eng samarali ishlash parametrlari aniqlandi.

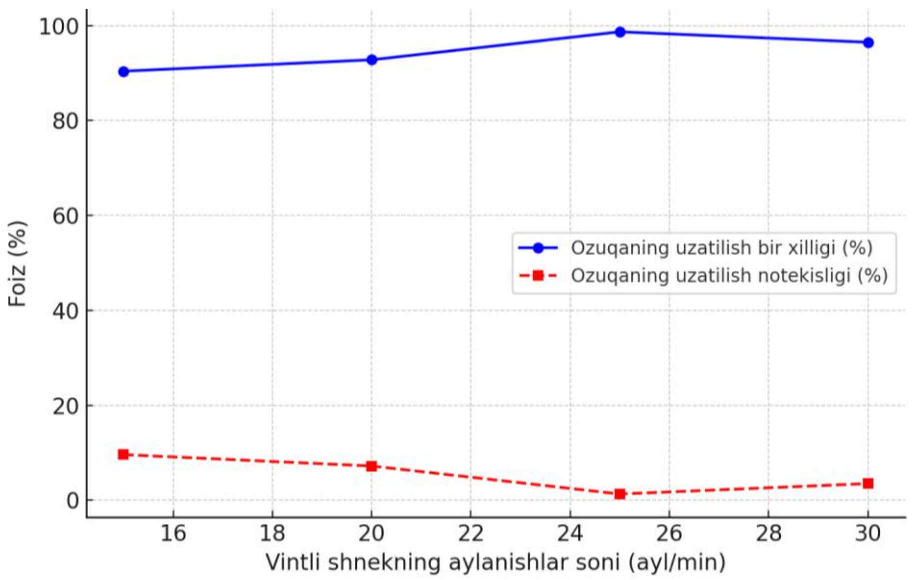
Natijalar va muhokama.



1-rasm. Kichik hajmli miqdorlagich-yuklagich sxemasi.
1- val; 2- bunker; 3- quvur; 4- me’yorlashtirgich; 5- elektr dvigateli; 6- tasmali uzatma; 7- tushirish quvuri; 8- tayanch ustun; 9- g‘ildirak.

Kichik chorvachilik, baliqchilik va parrandachilik fermer xo‘jaliklari uchun vintli shnekli miqdorlagich-yuklagich qurilmasining sxemasi ishlab chiqildi va qurilmaning tajriba nusxasi tayyorlandi ushbu qurilmada tajribalar olib borildi.

Quyidagi grafik vintli shnekning aylanish tezligiga bog‘liq holda ozuqaning uzatilish bir xilligi va notekisligi qanday o‘zgarishini aks ettiradi. Grafikdan ko‘rinib turibdiki, aylanish tezligi oshgani sari uzatilish bir xilligi oshadi, ammo juda yuqori tezlikda bu barqarorlik biroz pasayadi.



1-rasm. Vintli shnekning aylanish tezligi bo‘yicha ozuqa uzatishning o‘zgarishi.

Vintli shnekning 15 ayl/min tezligida ozuqaning uzatilish bir xilligi 90.4% ni tashkil qiladi va uzatilish notekisligi 9.6% bo‘ladi. Bu esa ozuqaning barqaror yetkazib berilishi uchun unchalik optimal emasligini ko‘rsatadi. 20 ayl/min tezlikda esa uzatilish bir xilligi 92.8% gacha oshadi, bu esa oldingi natijaga nisbatan yaxshiroqdir.

Eng yuqori natija 25 ayl/min tezlikda qayd etilgan bo‘lib, uzatilish bir xilligi 98.7% ga yetgan. Bu shnekning ushbu tezlikda eng samarali ishlashini ko‘rsatadi. Ammo, 30 ayl/min tezlikda uzatilish barqarorligi biroz pasayib, 96.5% ni tashkil qilgan va uzatilish notekisligi esa 3.5% ga oshgan. Bu shnek juda yuqori tezlikda samaradorlikni biroz yo‘qotishi mumkinligini ko‘rsatadi1-jadval.

1-jadval

Vintli shnekning aylanishlar soni (ayl/min)	**Ozuqalarning uzatilish bir xilligi (%)**	**Ozuqalarning uzatilish notekisligi (%)**
15	90,4	9,6
20	92,8	7,2
25	98,7	1,3
30	96,5	3,5

Xulosa Olingan natijalarga asoslanib, vintli shnek mexanizmlari uchun optimal aylanish soni 25 ayl/min ekanligi aniqlandi. Chunki bu holatda uzatilish bir xilligi eng yuqori ko‘rsatkichga erishadi. 30 ayl/min tezlikda esa uzatilish notekisligi oshib ketadi. Shuning uchun ozuqa uzatish tizimlarida vintli shnekning aylanish tezligini tanlashda mazkur natijalar inobatga olinishi tavsiya etiladi.

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HISTORY OF TRAINING WATER MANAGEMENT STAFF IN KASHKADARYA REGION

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Abstract. The article examines the history of personnel training in the field of water management in the Kashkadarya region, one of the largest regions of Uzbekistan in terms of territory. The work carried out to train and improve the skills of personnel is documented on the basis of archival documents. It is based on the creativity of a generation of irrigators and meliorators.

Keywords: Mirab, irrigation, cotton field, land development, hydraulic engineer, management personnel, seasonal work.

Introduction. The development of each industry is directly determined by the experience and qualifications of its personnel. In particular, the large-scale irrigation construction carried out in the water management of Kashkadarya in the 1950-1980s is the result of the work, knowledge and experience of the industry's personnel. From this point of view, the history of the formation and development of the industry's human resources potential has gone through a unique period. The history of large-scale training of irrigators and meliorators who served in the water management of Kashkadarya is associated with the beginning of the development of the Karshi steppe. The process of building the oasis's irrigation system created a great need for personnel for agriculture and water resources management. The first attempts to organize training in this area and form specialized personnel in the oasis were made in the second half of the 20th century. This also served as the basis for the creation of special educational institutions in the region.

Main part. Until the second half of the 20th century, the country mainly used the experience of local elderly farmers and mirabs (*person who oversees water distribution and irrigation networks*). However, the Soviet government believed that the main reason for the incomplete implementation of the 1950 plans was the lack of qualified personnel [1]. According to archival documents, the mirabs in our oasis had sufficient historical experience. The only reason the Soviets came to this conclusion was the desire to grow cotton on large areas of the country in a short period of time. Instead of subordinating local mirabs and using their knowledge and labor, they preferred to train and educate personnel who themselves submitted to Soviet ideology. Therefore, by the 1950s, the Soviet state began to pay special attention to training personnel for water management. Based on the Resolution of the Council of Ministers of the USSR dated March 1, 1951 "On Strengthening the Training of Engineers and Technicians in Hydraulic Engineering Specialties", on May 12, 1951, the Resolution of the Council of Ministers of the Uzbek SSR "On the Training of Specialized Specialists for the Construction of Irrigation Facilities" was adopted [2]. In 1952, the Order of the Ministry of Land Reclamation and Water Management of the Uzbek SSR "On Measures to Further Improve the Selection, Training, and Placement of Personnel in the Ministry of Land Reclamation and Water Management of the Uzbek SSR and Its Local Organizations" was adopted [3]. Based on the order, an inspection of the work activities of unskilled personnel who do not have professional knowledge in the field of mechanical engineering and hydraulic engineering was carried out in the regions.

The Ministry of Land Reclamation and Water Management of the Uzbek SSR defined measures to provide the management of the Uzbekgidrostroy and Uzvodstroy trusts with specialized personnel and mechanics who were fluent in the language of technology. In 1956, many machinists were selected and sent to the workshop for permanent work. These were mainly graduates of metalworking schools and vocational schools of the republic, sent in assignments. Mechanics who wanted to go to construction work needed a referral from the Komsomol committee. For example, in July 1956 alone, 30 people came to work at the construction site, and all of them were hired. The easiest way to get a job was to come with a Komsomol referral [4].

Analysis and results. In the second half of the 20th century, regional leaders were given important tasks, such as training irrigators and meliorators, planning economists, agronomists and machine operators, as well as many other agricultural specialists for the development of protected and abandoned lands. During this period, the republic lacked specialists for the development of large-scale agricultural enterprises. Therefore, there was a high demand not only for labor, but also for ready-made qualified specialists [5]. The percentage of personnel from among local nationalities in the republic was very insignificant. For this reason, at the initial stage, military personnel were allowed to undergo training without interruption from work during training. It should be noted that due to the lack of local personnel, almost the entire workforce in the agricultural sector consisted of Russians and representatives of other nationalities.

In March-November 1962, based on the resolution of the Central Committee of the CPSU "On the tasks of the Party in improving the management of agriculture" [6], the selection of specialists for agricultural departments began. However, serious shortcomings were revealed in the work with personnel. Among the chairmen of collective farms and heads of economic departments, one could find people who did not yet have sufficient qualifications and experience in agricultural production. Only 12% of the personnel had an agricultural education. During this period, many complex mechanized communities were headed by people who had no knowledge of agricultural machinery. In most collective farms, people without special education worked as agronomists and technicians. More than 1,300 agricultural specialists worked in the fields of industry, construction, irrigation and transport. In addition, many workers were engaged in seasonal work unrelated to industry. In particular, more than 900 workers in agricultural specialties worked in cultural and household buildings and craft institutions. No practical work was carried out to attract specialists to work.

In 1963, when preparatory work began on the development and irrigation of lands in the Kashkadarya oasis, 2,388 young specialists with secondary and higher education in various agricultural specialties were sent to all regions of the republic, including the collective farms and farms of Kashkadarya. But many of them had to leave without finding work. One of the reasons for this is that the problem of creating favorable conditions was not solved, and the second reason is that some managers, not realizing the need for qualified personnel, did not hire them. In addition, there were shortcomings in the selection of management personnel. In particular, there were cases when personnel were selected on the basis of resumes, and then soon fired for failure to complete work assignments on time [7]. The number of personnel increased from year to year. The last one was fired. The forced training process carried out during these years did not produce results.

Taking into account the situation in the region, on May 11 and December 31, 1966, the Council of Ministers of the Uzbek SSR and the Central Committee of the Communist Party of the Uzbek SSR adopted resolutions "On further increasing the efficiency of the system for improving the qualifications of specialists in labor agriculture and the management personnel of collective and state farms" [8]. The goal was to increase the initiative of management personnel in the correct selection and improvement of the efficiency of their work. Based on the decision taken in 1966 on further increasing the efficiency of management personnel in the future, 88 personnel were appointed to management positions in the "Qarshiqurilish" management organizations in 1973 [9]. Attention was also paid to the quality of training in educational institutions. On-site training turned out to be the most suitable method of training. The Ministries of Agriculture, Land Reclamation and Water Management, as well as Uzglavvodstroy were also instructed to create 9,300 training places for the construction of technical schools in 1971-1975 [10].

In 1972, in order to implement plans for the development of construction and installation works worth 17.5 million rubles, it was necessary to solve the problem of a large number of personnel and the issues of improving their qualifications. The training of personnel for agriculture and water management was carried out by training them at special courses and seminars of the Ministry of Agriculture of the Uzbek SSR. For example, in 1971, 18 irrigators of Kashkadarya improved their qualifications at such courses [11]. At the same time, workers in the region also attended special training courses to improve their qualifications. In particular, in 1971-1973, 126 engineering and technical workers of the Qarshiqurilish Department completed advanced training courses [12]. Although this number is small on a regional scale, the skills of irrigators who are improving their skills contributed to the development of the industry in the oasis. The number of highly educated personnel increased. For example, in 1971 there were 70 specialists with higher education, 427 with secondary specialized education, and in 1972 this figure doubled[13].

A council of young specialists headed by N.N. Somov was created in the regional department of irrigation systems. In 1976, 24 young specialists arrived from universities and technical schools of the Kashkadarya region. He was engaged in the technical development of young specialists and training of personnel on other issues. It is worth noting that the reforms carried out in the personnel sphere in recent years have played a significant role in the implementation of the largest irrigation facilities and hydraulic structures in the process of developing the Karshi desert. The policy of that period contributed to the training of qualified specialists, irrigators and meliorators in the oasis. Through their efforts, large construction projects in the field of irrigation and melioration were built, which became exemplary in the Union. In these works, experts in their fields such as Kh. Shogazatov, F. Rahmonov, N. Hamroyev, T. Ergashev, Q. Amirov, and Kh. Toshev made a great contribution to the construction of waterways.

Conclusions and suggestions. Thus, the issue of training personnel for the irrigation sector of Kashkadarya was in the constant focus of the Soviet government. In order to achieve the highest goal of a colonial nature, work was launched to train qualified specialists in the field of irrigation and cotton growing. The need for young specialists for the development of new lands increased. Therefore, the development of the Karshi desert in the region, the increase in the number of farms based on cotton cultivation, the implementation of irrigation and melioration measures required an increase in the number of personnel in this area. This became the basis for the formation and training of water management specialists. If in the 1950-1960s there were difficulties in this area and it was not possible to achieve the set goal, then archival data indicate that the scale of the work carried out in the 1970s yielded results. During this period, much attention was paid to the training and retraining of personnel for agriculture and water management in the region. In the 60-70s of the last century, the task of training specialists in this area was set. As a result of the events held, a large number of specialists were trained in higher and secondary specialized educational institutions. A truly honest, hard-working and knowledgeable generation of personnel has grown up in the irrigation sector.

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SIM ARQONLI BARABAN AYLANISHLAR SONINING G‘OZAPOYANI MAYDALASH DARAJASIGA TA’SIRI

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Annotatsiya. Maqolada paxtasi terib olingan maydonlardagi g‘o‘zapoyalarni maydalashga mo‘ljallangan qurilma barabani aylanishlar sonining maydalanish darajasiga ta’sirini o‘rganish bo‘yicha dala tajriba tadqiqotlarining natijalari keltirilgan.

Kalit so‘zlar: g‘o‘zapoya, simli arqon, disk, baraban, g‘o‘zapoyalarni maydalash, texnologik jarayonlar, maydalab dalaga sochish.

ВЛИЯНИЕ КОЛИЧЕСТВА ОбОРОТОВ ТРОСОВОГО БАРАБАНА НА СТЕПЕНЬ ИЗМЕЛЬЧЕНИЯ СТЕБЛЕЙ ХЛОПЧАТНИКА

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Аннотация. В статье приведены результаты полевых экспериментов по изучению влияния количества оборотов барабана устройства, предназначенного для измельчения стеблей хлопчатника, на уровень измельчения.

Ключевые слова: Стебель, трос, диск, барабан, измельчение стеблей, технологические процессы, измельчение и разбрасывание по полю.

INFLUENCE OF THE NUMBER OF REVOLUTIONS OF THE CABLE DRUM ON THE DEGREE OF CHOPPING OF COTTON STEMS

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Abstract. The article presents the results of field experiments to study the influence of the number of revolutions of the drum of a device designed for crushing cotton stems on the level of crushing.

Key words: straw, wire rope, disk, drum, straw crushing, technological processes, crushing and spreading in the field.

Kirish. Respublikamizda eng koʻp yetishtiriladigan ekin turlaridan paxta bilan gʻalla hisoblanadi. Oʻrtacha hisobda koʻradigan boʻlsak har yili 1 mln gektardan ortiq maydonlarda paxta bilan gʻalla yetishtiriladi [1].

1- jadval

T/r	Hududlar	2022 yil		2023 yil		2024 yil	
		G'alla	Paxta	G'alla	Paxta	G'alla	Paxta
1	Qoraqalpogʻiston Respublikasi	53 000	84 800	53 000	86 800	53 000	86 300
2	Andijon	76 000	78 991	72 500	71 331	72 000	70 000
3	Buxoro	60 600	99 220	60 600	96 220	65 00	96 000
4	Jizzax	93 500	77 900	90 000	82 100	90 000	81 000
5	Qashqadaryo	140 000	136 036	142 779	133 050	140 000	133 050
6	Navoiy	38 039	31 655	34 300	28 155	34 300	28 155
7	Namangan	67 750	63 406	67 750	61 025	68 000	60 000
8	Samarqand	94 230	75 356	94 230	73 246	94 230	72 000
9	Surxondaryo	90 800	72 370	89 325	72 270	89 325	71 200
10	Sirdaryo	80 000	75 501	73 000	77 500	75 000	77 500
11	Toshkent	103 845	72 161	103 729	70 161	103 00	70 100
12	Farg'ona	99 500	82 080	95 720	77 821	95 720	76 000
13	Xorazm	33 200	82 757	33 900	82 757	33 200	82 500
Jami		1 030 465	1 032 232	1 010 833	1 012 436	1 012 775	1 003 805

Yuqoridagi 1-jadvalda 2022-2024 yillarda qishloq xoʻjaligi mahsulot yetishtiruvchilar tomonidan ekilgan gʻalla va paxta maydonlari toʻgʻrisida maʼlumot keltirilgan.

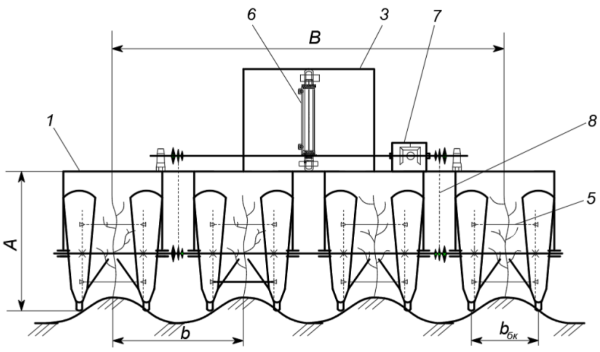
Muammoning dolzarbligi. Maʼlumki, 1 mln gektardan ortiq maydonga paxta yetishtirilar ekan. Paxta ochilgandan keyin, u qoʻlda yoki mashinada terib olinadi, gʻoʻzapoya esa oʻz oʻrnida qoladi. Dunyoning paxta yetishtiradigan davlatlarida, gʻoʻzapoya masalasiga boʻlgan yondashuvlar turlichaligini koʻrsatmoqda, jumladan gʻoʻzapoya ildizi bilan kovlab olinib, daladan olib chiqib ketiladi [2], gʻoʻzapoya maydalab dala yuzasiga sochiladi soʻngra shudgorlash orqali koʻmiladi, bir yoʻla shudgorlash orqali tuproqqa maydalamasdan koʻmiladi [3]. Respublikamizda keltirilgan holatlarning barchasini kuzatish mumkin. Koʻpchilik xorijiy davlatlarda gʻoʻzapoyadan organik oʻgʻit sifatida tuproq unumdorligini saqlash yoki oshirish maqsadida foydalaniladi [4]. Chunki gʻoʻzapoyaning poyasida 1,11% azot, 0,1% fosfor va 3,98% kaliy mavjud boʻlib, uning boshqa qoldiqlari gektariga 1,5 tonna uglerod, 20–25 kg azot va 72 kg kaliyni toʻldirishi mumkinligini koʻrsatadi [5]. Shuning uchun, gʻoʻzapoyalarni toʻliq maydalash va dala yuzasiga sochib, soʻngra shudgorlash orqali koʻmish maqsadga muvofiq.

Tadqiqot materiallari va uslubi. Tajribalarni oʻtkazish uchun kam energiya sarflagan holda gʻoʻzapoyalarni maydalab dalaga sochadigan sim aroqli barabandan tashkil topgan qurilmaning 2 qatorga moʻljallangan tajriba nusxasi tayyorlandi (1-rasm). Tajriba oʻtkazishda sinov metodikasi sifatida O'zDSt 3193:2017 "Qishloq xoʻjaligi texnikasini sinash. Mashinalarni energetik baholash usuli" va Tst 63.06-2001 «ИСТ. Машины для уборки хлопка-сырца и стеблей хлопчатника. Программа и методы испытаний» da keltirilgan usullardan foydalanildi [6; 21-б, 7; 32-б.].

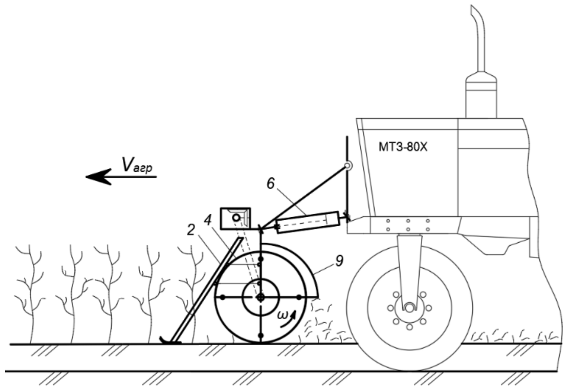
Tadqiqot natijalari va ularning muhokamasi. Gʻoʻzapoyalarni toʻliq maydalab dalaga sochadigan qurilma sxemasi ishlab chiqilgan va tajriba nusxasi yasalib, xoʻjalik sinovlari oʻtkazildi.

G‘o‘zapoyalarni maydalab dalaga sochadigan qurilma quyidagi rama 1, yo‘naltirgich 2, osma qurilma 3, diskli baraban 4, simli arqon 5, gidrosilindr 6, reduktor 7, zanjirli uzatma 8, g‘ilof 9 qismlardan tashkil topgan. Qurilmaning g‘o‘zapoyani maydalab dalaga sochadigan ishchi qismi-gorizontal o‘qqa o‘rnatilgan va ikkita diskdan tashkil topgan baraban 4 dan iborat. Disklarga simli arqon (tros) 5 mahkamlangan. Ularning diametri 2-5 mm, soni esa 4 dona, ya’ni har 90 gradus oraliq bilan joylashtirilgan. Har bir g‘o‘zapoya qatoriga bitta baraban 4 mos keladi. Barcha barabanlar bitta umumiy rama 1 ga joylashtirilgan. Barabanlarga aylanma harakat traktorning yon quvvat olish validan reduktor 7 orqali uzatiladi. Qurilma ehtiyojdan kelib chiqib traktorning oldi yoki orqasiga o‘rnatilishi mumkin.

a



b



1 – rama; 2 – yo‘naltirgich; 3 – osma qurilma; 4 – diskli baraban; 5 – sim arqon; 6 – gidrosilindr; 7 – reduktor; 8 – zanjirli uzatma; 9 – baraban g‘ilofi; a – old tomonidan ko‘rinishi; b – yon tomonidan ko‘rinishi.

1-rasm. G‘o‘zapoya maydalash qurilmasining sxemasi va dala sinov tajribalarini o‘tkazish jarayoni.

Yuqoridagi g‘o‘zapoyalarni maydalab dalaga sochadigan qurilmaning aktiv ishchi organi sim arqonli baraban xisoblanadi. Va to‘g‘ridan to‘g‘ri g‘o‘zapoyalar bilan ta’sirlashadi. Baraban aylanishlar soni esa g‘o‘zapoyalarning maydalanish darajasiga ta’sir etadi. TIQXMMI MTU xo‘jalik sinov maydonlarida dala tajriba sinovlari o‘tkazildi. Dala tajriba sinovlarini o‘tkazish metodikasi quydagicha. Uzunligi 1 metrdan bo‘lgan 4 dona nomerlangan reka olindi va 2.1 gektar maydonining qurilma bilan maydalangan kamida uchta joyidan boshidan o‘rtasidan va oxiridan 1 kvadrat metr maydondagi maydalangan g‘o‘zapoya bo‘lakchalari xammasi yig‘ishtirib olindi (2-rasm).

2-rasm. Dalada maydalangan g‘o‘zapoya bo‘lakchalarini fraksiyalarga ajratib, elektron tarozida o‘lchash jarayonidan fotolavha.

Olib kelingan g‘o‘zapoya bo‘lakchalari TIQXMMI MTU “Qishloq xo‘jaligi texnika va texnologiyalari” kafedrasi laboratoriyasida mavjud bo‘lgan MENBO SF -400 rusumli elektron tarozida umumiy massasi o‘lchab olindi. O‘lchangan bo‘lakchalar quyidagi uchta fraksiyaga, jumladan 0-5 sm gacha va 5-10 sm gacha va 10 sm dan katta ajratildi. Ajratilgan bo‘lakchlar elektron tarozida alohida o‘lchandi. Olingan natijalar bo‘yicha umumiy massaning uchta fraksiyalarga ajratilgan miqdori foizlarda ifodalandi. Poyaning maydalanish darajasining foiz miqdorini 2-jadvalda keltirildi.

2-jadval

<table>
<tr><th rowspan="2">№</th><th rowspan="2">Ko‘rsatkichlar</th><th colspan="3">Qiymati</th></tr>
<tr><th>Agrotexnik talab bo‘yicha</th><th colspan="2">Sinov natijasi</th></tr>
<tr><td>1</td><td>Agregatning harakat tezligi,km/h</td><td>6-8</td><td colspan="2">6-8</td></tr>
<tr><td>2</td><td>Poya bo‘lakchalarining uzunligi ,ko‘pi bilan, sm</td><td>10</td><td colspan="2">0-10</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">Poyaning maydalanish darajasi, %</td><td rowspan="4">95</td><td>0-5 sm</td><td>76.3</td></tr>
<tr><td>5-10 sm</td><td>19.0</td></tr>
<tr><td>10 sm dan katta</td><td>4.7</td></tr>
<tr><td>Jami</td><td>97.4</td></tr>
</table>

Yuqoridagi jadvalda g‘o‘zapoyalarni maydalab dalaga sochishga quyilgan agrotexnik talablar va dala tajriba natijalari keltirilgan. Tajribalar MTZ-80X traktoriga osilgan va unda traktor tezligini 6-8 km soat qilib olingan. Simli arqon tortilgan baraban diski diametri 600 mm ni va disklar orasiga tortilgan simli arqonlar soni 4 donani va simli arqon diametri 3 mm lik simli arqon olindi. Shunda baraban aylanishlar sonini 500,750,1000 ayl/min aylantirilib, maydondagi g‘o‘zapoyalar madalanib dalaga sochildi. Fraksiyalarga ajratilgan 0-5 sm oraliqdagi maydalangan bo‘lakchalar 76,3 foizni 5-10 sm oraliqdagi maydalangan bo‘lakchalar 19,0 foizni 10 sm katta bo‘lgan bo‘lakchalarning miqdori 4,7 foizni tashkil etdi. Jami maydalangan bo‘lakchalarning miqdori jadvalda ko‘rsatilgan agrotexnik talablarga to‘liq javob beradi va 97,4 foizni tashkl etdi.

Xulosa. O‘tkazilgan tajriba natijalari, baraban aylanishlar soni g‘o‘zapoyaning maydalanish darajasiga ta’siri sezilarli darajada ekanligini ko‘rsatmoqda. Aylanishlar sonini oshishi bilan maydalanish darajasi yuqori bo‘lganligini ko‘rishimiz mumkin. U 1000 ayl/min bo‘lganda 0-5 sm gacha bo‘lgan maydalangan bo‘lakchalar miqdori 76,3% ekanligini ko‘rsatdi. 10 sm dan katta bo‘lgan bo‘lakchalar miqdori esa 4,7 % bo‘lanligini ko‘rsatdi. Shu ta’kidlash mumkinki, baraban aylanishlar soni qanchalik katta bo‘lsa, g‘o‘zapoyani maydalanish darajasi shuncha yuqori bo‘lishi va oxir oqibatda maydalangan bo‘lakchalar tuproq bilan aralashib va tezda chirib, tuproq unumdorligini oshirishga xizmat qiladi.

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