UPCATET Agronomy Sample Paper-5

Duration: 20 Minutes **Maximum Marks: 100**

Instructions

- This paper contains **25** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **−1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A progressive seed-multiplication farm in Uttar Pradesh aims to establish a certified seed production plot for hybrid Pearl Millet (*Pennisetum glaucum*). To guarantee genetic purity against cross-contamination from local commercial fodder crops, what is the mandatory minimum isolation distance required by certification standards?

(A) 200 meters

(B) 400 meters

(C) 600 meters

(D) 1000 meters

Q2. An agronomist evaluates the lodging resistance of a newly bred high-yielding deep-water paddy variety in eastern UP. The mechanical strength of the lower internodes is fundamentally dependent on the synchronized biochemical accumulation of which structural component matrix?

(A) High Nitrogen and low Potassium

(B) High Silicon and optimal Potassium

(C) Low Calcium and high Gibberellins

(D) High Phosphorus and low Manganese

Q3. Calculate the exact physiological seed requirement (in kg/ha) for a timely-sown dwarf wheat variety (*Triticum aestivum*) given the following physical properties: Target plant population = 2.5×10^6 plants/ha, Test weight (1000-grain weight) = 42 g, Germination percentage = 90%, and Purity percentage = 95%.

(A) 105.0 kg/ha

(B) 116.6 kg/ha

(C) 122.8 kg/ha

(D) 134.2 kg/ha

Q4. The physiological phenomenon of "Pop-podding" or blank pod formation in Groundnut (*Arachis hypogaea*) cultivated in certain weathered alluvial tracts of Uttar Pradesh is primarily triggered by the localized structural deficiency of which nutrient phase during peg elongation?

(A) Available Zinc (Zn^{2+})

(B) Ionic Calcium (Ca^{2+})

(C) Molybdate (MoO_4^{2-})

(D) Borate (BO_3^{3-})

Q5. A precision sugarcane farming system utilizes the 'Sett Priming' technique to accelerate bud sprout uniformity under late-sown conditions in Western UP. Which biochemical solution configuration yields the highest physiological enzyme activation during this priming sequence?

(A) 0.1% Mercuric chloride solution for 10 minutes

(B) 50 ppm Gibberellic Acid (GA_3) + 1% Urea solution for 24 hours

(C) 10% concentrated Glucose syrup for 48 hours

(D) 0.5% Saturated Lime solution alone for 2 hours

Q6. The processing quality of Potato (*Solanum tuberosum*) tubers intended for industrial French-fry manufacturing is severely compromised if the tubers exhibit a high accumulation of reducing sugars. Which agronomic environmental condition primarily accelerates this undesirable biochemical conversion?

(A) Delayed harvesting coupled with high soil temperature (> 30°C)

(B) Cold storage exposure below 4°C causing low-temperature sweetening

(C) Excessive application of Potassium Sulfate (K_2SO_4) at tuber initiation

(D) Deficit nitrogenous fertilization during the active bulking phase

Q7. In Pigeonpea (*Cajanus cajan*), the physiological disorder known as "Flower Drop" drastically restricts the harvest index. Under sub-optimal field conditions, the exogenous spray of which plant growth regulator compound is recommended to inhibit premature abscission layer formation?

(A) Ethephon at 500 ppm

(B) Alpha-Naphthalene Acetic Acid (NAA) at 20 ppm

(C) Abscisic Acid (ABA) at 10 ppm

(D) Cycocel at 2000 ppm

Q8. Identify the correct sequential growth stages of Maize (*Zea mays*) ordered by their critical vulnerability index to severe moisture stress, moving from the most sensitive stage to the least sensitive stage:

(A) Silking → Tasseling → Knee-high → Dough stage

(B) Tasseling → Silking → Dough stage → Knee-high

(C) Knee-high → Tasseling → Silking → Dough stage

(D) Dough stage → Silking → Tasseling → Knee-high

Q9. During the processing of Yellow Mustard / Rapeseed (*Brassica* spp.), the presence of glucosinolates acts as a serious anti-nutritional factor in the remaining oil-cake meal. Agronomically, which macro-nutrient balancing directly regulates the biosynthesis pathway of glucosinolates in the seed matrix?

(A) Magnesium to Calcium Ratio

(B) Sulfur to Nitrogen Ratio

(C) Phosphorus to Potassium Ratio

(D) Boron to Iron Ratio

Q10. A specialized seed crop of Chickpea (*Cicer arietinum*) undergoes the agronomic practice of "Nipping" (detopping). What is the exact physiological mechanism and optimal timing designed to maximize seed yield output via this operation?

(A) Removal of apical dominance at 30–40 days after sowing to promote lateral branching

(B) Severing primary roots at flowering to induce deep moisture extraction

(C) Clipping early floral buds to prolong the vegetative carbon-sink assimilation phase

(D) Plucking old senescent basal leaves at 60 days to improve light penetration

Q11. The vast "Usar" or salt-affected soils belonging to the Indo-Gangetic alluvial plains of Uttar Pradesh frequently exhibit high Exchangeable Sodium Percentage (ESP $> 15\%$) and a high pH (> 8.5). For sustainable chemical reclamation, what is the precise biochemical mechanism when Gypsum ($CaSO_4 \cdot 2H_2O$) is incorporated into the profile?

(A) Ca^{2+} ions displace toxic Al^{3+} ions, forming insoluble aluminum oxides

(B) SO_4^{2-} ions directly neutralize free hydroxyl (OH^-) radicals to form sulfuric acid

(C) Ca^{2+} ions displace exchangeable Na^+ from the clay complex, forming soluble Na_2SO_4 which is leached out

(D) Gypsum acts as a physical binding catalyst that simply reduces macro-pore volume

Q12. An engineering survey of the ravines in the Yamuna and Chambal catchments of Agra and Etawah districts classifies them into distinct erosion severity zones. Which mechanical conservation structure configuration is most structurally appropriate for stabilizing "Medium Ravines" (depth 3 to 9 meters, bed width > 18 meters)?

(A) Peripheral bunding paired with structural drop-spillway earthen gully plugs

(B) Simple contour vegetative hedges using shallow-rooted seasonal annual grasses

(C) Broad-based graded terraces across the absolute floor of the primary ravine

(D) Complete structural stone-pitching retaining walls across the entire catchment basin

Q13. Analyze the kinetic impact of conventional primary tillage using a moldboard plow compared to a conservation strip-tillage system on the structural parameters of a typical modern Coarse Loamy Alluvial Soil (*Inceptisol*). Which response curve represents the long-term structural outcome?

(A) Moldboard plow increases macro-aggregates and permanently lowers bulk density

(B) Strip-tillage destroys the soil organic matter matrix faster than clean-tillage

(C) Moldboard plow induces a plow-pan compaction layer below the plow depth and accelerates organic carbon oxidation

(D) Strip-tillage restricts hydraulic conductivity due to natural particle consolidation

Q14. The "Bundelkhand Granitic Complex" region of southern UP features characteristic "Mar" and "Kabar" soils. What structural mineral group dominates these soils, and what is their primary problematic physical behavior during transitioning moisture regimes?

(A) Kaolinite-dominated; non-expanding behavior with rapid internal drainage

(B) Illite-dominated; extreme crusting when dry, remaining completely friable when wet

(C) Montmorillonite-dominated; high swelling when wet and severe deep cracking upon drying

(D) Quartz-dominated; high erodibility index with zero plasticity capacity

Q15. Universal Soil Loss Equation (USLE) computes annual soil loss via the mathematical expression $A = R \times K \times L \times S \times C \times P$. If a farmer implements a cross-slope contour cultivation pattern instead of up-and-down slope farming, which parameter value shifts to directly scale down the total computed erosion (A)?

(A) Soil Erodibility Factor (K)

(B) Topographic Length-Steepness Factor (LS)

(C) Support Practice Factor (P)

(D) Crop Management Factor (C)

Q16. Under a strict zero-tillage production regime for a Rice-Wheat cropping sequence, what distinct shift is observed in the stratigraphical distribution profile of soil organic carbon (SOC) compared to a deep inversion tillage control?

(A) SOC becomes uniformly distributed across the entire $0 - 30$ cm root zone profile

(B) SOC displays extreme stratification, concentrating heavily within the upper $0 - 5$ cm boundary layer

(C) SOC migrates downwards to the $30 - 60$ cm sub-soil zone due to macro-pore bypass flow

(D) Zero-tillage results in a net absolute reduction of SOC in the topsoil due to microbial immobility

Q17. A field of sugarcane requires an irrigation scheduling strategy based on the Climatological Approach (IW/CPE ratio). If the critical irrigation water depth (IW) is fixed precisely at 60 mm and the recommended IW/CPE ratio threshold for the formative stage is 0.80, irrigation must be initiated immediately when the cumulative pan evaporation (CPE) reaches what value?

(A) 48 mm

(B) 60 mm

(C) 75 mm

(D) 80 mm

Q18. A micro-irrigation layout utilizes online pressure-compensating emitters. If a block operating at a pressure head of 1.5 bar shows an emitter discharge rate of 4.0 L/h, what will be the theoretical discharge rate when the line operating pressure experiences an accidental spike up to 2.5 bar?

(A) 4.0 L/h

(B) 6.6 L/h

(C) 2.4 L/h

(D) 5.3 L/h

Q19. An agricultural engineer designs a sub-surface horizontal tile drainage system to reclaim a waterlogged saline zone. If the hydraulic conductivity (K) of the water-bearing strata doubles due to natural structural fissuring, how does the required drain spacing (S) alter under the steady-state Hooghoudt equation formulation to maintain an identical water table drawdown rate?

(A) Spacing must be reduced by half ($0.5 \times S$)

(B) Spacing remains entirely unchanged

(C) Spacing scales up by a factor of exactly $\sqrt{2}$ ($\approx 1.41 \times S$)

(D) Spacing must increase by a factor of four ($4 \times S$)

Q20. Which thermodynamic soil water potential component governs the directional movement of water molecules within an unsaturated, highly saline clay-loam rhizosphere profile under active transpiration pull?

(A) Gravitational potential (ψ_g) exclusively

(B) High Matrix potential (ψ_m) operating against a steep Osmotic potential (ψ_s) gradient

(C) Hydrostatic Pressure potential (ψ_p) working in tandem with Volumetric potential

(D) Purely atmospheric water vapor pressure differentials

Q21. Determine the net irrigation requirement (NIR) for an onion crop field given the following field hydrology metrics: Consumptive Use (CU) = 450 mm, Effective Rainfall (Re) = 50 mm, and pre-existing stored soil moisture contribution change (ΔW) = 20 mm.

(A) 520 mm

(B) 420 mm

(C) 380 mm

(D) 400 mm

Q22. The physiological evolution of absolute resistance in *Phalaris minor* (Gullidanda) against Isoproturon across the continuous rice-wheat belts of Upper Gangetic plains is biochemically attributed to the hyper-activation of which internal enzyme metabolic degradation system?

(A) Acetolactate Synthase (ALS) pathway mutation

(B) Cytochrome P450 monooxygenases mediated detoxifying metabolism

(C) EPSP Synthase gene amplification sequence

(D) Glutamine Synthetase binding structural deletion

Q23. A dryland agro-ecosystem specialist recommends an exogenous foliar spray of a chemical "Reflecting-Type" antitranspirant compound to minimize luxury consumption of water without totally halting carbon fixation. Select the appropriate compound fitting this description:

(A) Phenyl Mercuric Acetate (PMA)

(B) Kaolin clay emulsion ($5 - 6\%$)

(C) Liquid Paraffin / Polyethylene wax thin films

(D) Allyl succinic acid derivative molecules

Q24. Calculate the exact commercial quantity of Atrazine 50% WP needed to treat a 2.4-hectare Maize experimental block if the recommended agronomic active ingredient dose ($a.i.$) is prescribed at 1.25 kg a.i./ha.

(A) 2.5 kg

(B) 3.0 kg

(C) 6.0 kg

(D) 1.2 kg

Q25. Under a true arid/dryland farming environment, which morpho-physiological adaptive trait modification allows minor millets like Finger Millet (*Eleusine coracana*) to survive severe prolonged drought spells and resume rapid vegetative function post-precipitation?

(A) High proline accumulation paired with deep seminal roots and thick silicified cuticular layers

(B) C3 photosynthetic shift to reduce daytime stoma open-time

(C) Hydrophilic aerenchyma tissue formation in the main crown stems

(D) High gibberellin synthesis causing elongated cell extension cycles

Detailed Solutions

Q1.

Solution

Concept: Isolation distance is a critical parameter in seed certification protocols designed to preserve genetic identity and prevent cross-contamination. Hybrid seed production plots require significantly higher isolation distances than composite or varieties because they rely on controlled cross-pollination from specific male parental lines while completely excluding foreign pollen sources.

Solution:

Let's review the pollination biology and standard isolation requirements for Pearl Millet (*Pennisetum glaucum*):

(a) Pearl millet is a highly cross-pollinated crop due to its protogynous flowering habit, where the female stigmas emerge and mature before the male anthers shed pollen.

(b) Commercial fodder crops or wild relative variants in nearby fields present a severe threat of genetic contamination because they produce large volumes of airborne pollen.

(c) Under the Indian Minimum Seed Certification Standards (IMSCS), a seed field producing **Certified hybrid seed** of pearl millet must be separated from any other fields of the same species or commercial fodder plots by a mandatory minimum isolation distance of **400 meters**.

Final Answer: $\boxed{\text{400 meters}}$

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: Lodging resistance in deep-water and tall paddy varieties prevents structural collapse under heavy wind or sudden water level rises. The mechanical strength of the lower internodes depends on the composition and thickness of the cell walls within the culm tissue.

Solution:

Let's analyze how different structural element matrices affect stem strength:

(a) High nitrogen applications promote rapid, succulent vegetative growth with thin cell walls, which increases lodging susceptibility.

(b) **Silicon (Si)** is deposited as silica gel within the epidermal layers and vascular bundles, forming a rigid structural matrix that hardens the stem tissue against mechanical bending.

(c) **Potassium (K)** works in tandem with silicon by regulating cellular turgor pressure, enhancing carbohydrate synthesis, and thickening the sclerenchyma cell walls in the lower internodes. A synchronized accumulation of high silicon and optimal potassium maximizes culm rigidity and lodging resistance.

Final Answer: $\boxed{\text{High Silicon and optimal Potassium}}$

$\boxed{\textbf{Answer: (B)}}$

Go Back to Question 2

Q3.

Solution

Concept: The physiological seed rate calculation determines the actual gross quantity of seed required per hectare by adjusting the ideal theoretical seed requirement based on the seed lot's Real Value (or Utility Value). The Real Value accounts for both the germination capability and physical purity of the seed lot.

Solution:

Let's compute the net seed requirement step-by-step using the standard agronomic formulas:

(a) Find the weight of an individual seed from the given test weight (1000-grain weight = 42 g):

$$\text{Weight per single seed} = \frac{42\text{ g}}{1000} = 0.042\text{ g} = 4.2 \times 10^{-5}\text{ kg}$$

(b) Calculate the absolute theoretical weight of seed required to meet the target population (2.5×10^6 plants/ha) assuming 100% survival:

$$\text{Theoretical Seed Weight} = (2.5 \times 10^6) \times (4.2 \times 10^{-5}\text{ kg}) = 105.0\text{ kg}$$

(c) Calculate the Real Value (RV) of the seed lot using the germination percentage (90% = 0.90) and physical purity percentage (95% = 0.95):

$$\text{Real Value} = \frac{\text{Germination \%} \times \text{Purity \%}}{100} = \frac{90 \times 95}{100} = 85.5\% = 0.855$$

(d) Adjust the theoretical seed weight by dividing it by the Real Value to obtain the true dynamic seed rate needed:

$$\text{Physiological Seed Requirement} = \frac{\text{Theoretical Seed Weight}}{\text{Real Value}} = \frac{105.0\text{ kg}}{0.855} \approx 122.8\text{ kg/ha}$$

Final Answer: $\boxed{122.8\text{ kg/ha}}$

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: "Pop-podding" or blank pod formation is a widespread physiological disorder in groundnut where the outer shell develops normally but the internal seeds fail to form or remain shriveled. This condition occurs when the plant lacks specific localized nutrients during early pod development.

Solution:

Let's analyze the nutrient uptake mechanism of developing groundnut pods:

(a) Unlike other nutrients that translocate downward from the leaves via the phloem, **calcium (Ca^{2+})** is immobile in the phloem and cannot be translocated into the developing underground pods from the main root system.

(b) The elongating gynophores (pegs) and developing pods must absorb ionic calcium directly from the surrounding shallow soil zone.

(c) If there is a localized **deficiency of ionic calcium (Ca^{2+})** in the fruiting zone, embryo cell division is disrupted, leading to the formation of empty shells or "pop-pods."

Final Answer: $\boxed{\text{Ionic Calcium } (Ca^{2+})}$

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Sett priming involves soaking sugarcane cuttings (setts) in nutrient or biochemical solutions prior to planting. This pre-treatment activates metabolic processes, breaks bud dormancy, and accelerates uniform sprouting under cold or late-sown conditions.

Solution:

Let's evaluate the physiological effectiveness of the given priming options:

(a) Mercuric chloride acts primarily as a surface disinfectant but does not stimulate metabolic activity.

(b) A combined solution of **50 ppm Gibberellic Acid (GA_3) and 1% Urea** provides both a strong hormonal trigger and an easily absorbable nitrogen source.

(c) The exogenous GA_3 activates hydrolytic enzymes like α-amylase, which accelerate the breakdown of stored stalk sugars into reducing forms. At the same time, the urea supplies nitrogen to fuel rapid protein synthesis in the emerging shoots, maximizing bud sprout uniformity.

Final Answer: $\boxed{\text{50 ppm Gibberellic Acid } (GA_3) + 1\% \text{ Urea solution for 24 hours}}$

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept: Industrial processing of potato tubers into French fries requires a low concentration of reducing sugars (glucose and fructose). High levels of reducing sugars react with free amino acids during high-temperature frying, causing dark discoloration and bitter flavors due to the Maillard reaction.

Solution:

Let's identify the environmental factor that accelerates reducing sugar accumulation:

(a) Enzymatic transformations within harvested tubers are highly sensitive to storage temperature regimes.

(b) When potato tubers are subjected to **cold storage exposure below 4°C**, a physiological response called **low-temperature sweetening (LTS)** is activated.

(c) Cold stress upregulates the enzyme invertase, which converts stored starch into reducing sugars, compromising the tubers' industrial processing quality.

Final Answer: $\boxed{\text{Cold storage exposure below 4°C causing low-temperature sweetening}}$

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Premature flower drop in grain legumes occurs when high ethylene or low auxin levels trigger the development of an abscission layer at the base of the flower pedicel. Exogenous applications of synthetic plant growth regulators can help counteract this process.

Solution:

Let's evaluate the physiological actions of the given growth regulators:

(a) Ethephon breaks down into ethylene, which accelerates abscission and flower drop.

(b) **Alpha-Naphthalene Acetic Acid (NAA)** is a synthetic auxin that acts as an anti-abscission agent.

(c) Spraying **NAA at a low concentration (20 ppm)** maintains an adequate auxin gradient across the pedicel junction. This suppresses the activity of pectinase and cellulase enzymes, preventing the formation of the abscission layer and reducing flower drop to improve the harvest index.

Final Answer: $\boxed{\text{Alpha-Naphthalene Acetic Acid (NAA) at 20 ppm}}$

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: The impact of water stress on maize yield varies significantly across different growth phases. Critical periods occur when moisture deficits disrupt reproductive organ development, pollination, or grain filling.

Solution:

Let's rank the growth phases of maize by their sensitivity to water stress:

(a) **Silking** is the most critical stage. Moisture stress at this point dries out the exposed silks and prevents pollen tube growth, leading to poor fertilization and bare cobs.

(b) **Tasseling** (pollen shedding) is the second most sensitive phase because water deficits can disrupt pollen viability and cause a mismatch between tassel and silk emergence (asynchrony).

(c) The **Knee-high** vegetative phase and the late **Dough stage** are less vulnerable, as the plants have higher structural tolerance or have already completed fertilization. Thus, the sensitivity hierarchy is: Silking → Tasseling → Knee-high → Dough stage.

Final Answer: $\boxed{\text{Silking} \rightarrow \text{Tasseling} \rightarrow \text{Knee-high} \rightarrow \text{Dough stage}}$

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: Glucosinolates are sulfur- and nitrogen-rich secondary metabolites found in *Brassica* species. While they provide natural defense against pests, high levels in the remaining oil-cake meal limit its value as livestock feed due to toxicity and palatability issues.

Solution:

Let's examine the nutrient interactions that control glucosinolate synthesis:

(a) The biochemical synthesis of glucosinolates relies on a steady supply of sulfur-containing amino acids (such as methionine) and nitrogenous intermediaries.

(b) The **Sulfur to Nitrogen (S:N) ratio** directly regulates this metabolic pathway.

(c) High sulfur applications combined with low nitrogen stimulate glucosinolate synthesis. Managing and balancing the S:N ratio allows growers to optimize oil content while keeping glucosinolate levels within acceptable processing standards.

Final Answer: $\boxed{\text{Sulfur to Nitrogen Ratio}}$

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Nipping (or detopping) is a traditional management practice in chickpea cultivation that modifies plant architecture by altering hormonal balance and branching patterns.

Solution:

Let's analyze the physiological mechanism behind nipping:

(a) Chickpea plants naturally exhibit strong apical dominance, where auxins produced in the terminal bud suppress the growth of lower lateral buds, resulting in a tall, narrow canopy.

(b) Manually **removing the apical buds at 30–40 days after sowing** eliminates this source of auxin, disrupting apical dominance.

(c) This hormonal shift allows cytokinins to stimulate **lateral branching**, creating a more compact, bushier canopy with more flowering sites, which increases pod numbers and final seed yield.

Final Answer: Removal of apical dominance at 30–40 days after sowing to promote lateral branching

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: Sodic (*Usar*) soils have high levels of exchangeable sodium (Na^+) ions on clay surfaces, which breaks down soil structure and raises the pH above 8.5. Chemical reclamation requires exchanging these sodium ions with divalent calcium (Ca^{2+}) ions.

Solution:

Let's trace the chemical reactions that occur when gypsum is added to sodic soil:

(a) Incorporating agricultural gypsum ($CaSO_4 \cdot 2H_2O$) into moist soil releases soluble divalent calcium (Ca^{2+}) and sulfate (SO_4^{2-}) ions.

(b) The **Ca^{2+} ions displace the monovalent Na^+ ions** from the negative exchange sites on the clay particles due to their higher charge density:

$$2\text{Na-Clay} + CaSO_4 \rightleftharpoons \text{Ca-Clay} + Na_2SO_4$$

(c) The displaced sodium combines with the remaining sulfate to form **soluble sodium sulfate (Na_2SO_4)**, which can then be leached deep below the crop root zone through irrigation or heavy rainfall.

Final Answer: Ca^{2+} ions displace exchangeable Na^+ from the clay complex, forming soluble Na_2SO_4 which is l

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept: Gully reclamation structures are engineered based on gully size, slope, and catchment characteristics. Medium-sized ravines require structures that can stabilize the gully bed and manage concentrated water flow without washing out.

Solution:

Let's evaluate structures for stabilizing medium ravines (depth 3 to 9 meters, bed width > 18 meters):

(a) Simple vegetative hedges do not have the root strength or mass to handle the high-velocity runoff found in medium ravines.

(b) An effective engineering solution combines **peripheral bunding with structural drop-spillway earthen gully plugs**.

(c) The peripheral bunds intercept and divert incoming surface runoff away from the ravine edges, while the drop-spillway earthen gully plugs slow down water velocity within the ravine channel. This promotes sediment deposition, stabilizes the gully floor, and prevents further headward erosion.

Final Answer: $\boxed{\text{Peripheral bunding paired with structural drop-spillway earthen gully plugs}}$

$\boxed{\textbf{Answer: (A)}}$

Go Back to Question 12

Q13.

Solution

Concept: Long-term tillage practices significantly alter the physical structure and organic matter dynamics of fine-textured alluvial soils.

Solution:

Let's contrast the long-term structural outcomes of clean inversion tillage versus conservation strip-tillage:

(a) Conventional intensive tillage using a moldboard plow mechanically shatters soil aggregates. This disruption exposes protected organic matter to microbial decomposition, accelerating organic carbon oxidation.

(b) Repeatedly plowing to a uniform depth compresses the soil just beneath the tilled zone, creating a dense **plow-pan compaction layer**.

(c) Strip-tillage, by contrast, minimizes structural disturbance and helps preserve soil organic matter, making the moldboard plow description the accurate long-term outcome.

Final Answer: $\boxed{\text{Moldboard plow induces a plow-pan compaction layer below the plow depth and accelerates organic carbon oxidation}}$

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 13

Q14.

Solution

Concept: The physical properties of regional soils are largely determined by the mineralogy of their parent material. Black soils, locally known as "Mar" and "Kabar" in the Bundelkhand region, contain specific clay minerals that dictate their moisture response.

Solution:

Let's analyze the mineral composition and physical behavior of these heavy clay soils:

(a) "Mar" and "Kabar" soils are dominated by **montmorillonite**, a $2:1$ expanding lattice clay mineral mineral group.

(b) The expanding lattice structure allows large amounts of water to enter between the crystal sheets, causing the soil to **swell significantly when wet** and become sticky and poorly drained.

(c) As moisture evaporates, the lattice contracts, leading to **severe shrinkages and deep vertical cracks** upon drying, which makes these soils difficult to till outside narrow moisture windows.

Final Answer: Montmorillonite-dominated; high swelling when wet and severe deep cracking upon drying

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept: The Universal Soil Loss Equation (USLE) isolates different landscape and management variables to calculate average annual soil loss:

$$A = R \times K \times L \times S \times C \times P$$

Solution:

Let's determine which factor changes when shifting to a cross-slope contour cultivation pattern:

(a) The environmental parameters (R, K, L, S) reflect localized weather, soil type, and topography, which remain constant.

(b) The crop management factor (C) depends on the type of crop grown and crop residue retention.

(c) Shifting from up-and-down slope cultivation to cross-slope contouring implements a physical conservation practice. This practice slows down runoff velocity and reduces soil movement, which directly lowers the **Support Practice Factor (P)** coefficient to scale down total calculated soil erosion.

Final Answer: $\boxed{\text{Support Practice Factor (P)}}$

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 15

Q16.

Solution

Concept: Eliminating tillage operations in a zero-tillage system changes how organic residues are mixed into the soil, creating a distinct vertical distribution profile of soil organic carbon (SOC) over time.

Solution:

Let's contrast the vertical carbon distribution between zero-tillage and conventional inversion tillage:

(a) In conventional systems, moldboard plowing regularly mixes crop residues deep into the $0 - 30$ cm root zone, resulting in a relatively uniform distribution of organic carbon.

(b) Under a strict **zero-tillage regime**, crop residues are left undisturbed on the surface, where they decompose slowly.

(c) Without mechanical mixing, this leads to **extreme carbon stratification, concentrating SOC heavily within the upper $0 - 5$ cm boundary layer**, while carbon levels in deeper soil layers remain lower and stable.

Final Answer: $\boxed{\text{SOC displays extreme stratification, concentrating heavily within the upper } 0 - 5 \text{ cm boundary}}$

$\boxed{\textbf{Answer: (B)}}$

Go Back to Question 16

Q17.

Solution

Concept: The climatological approach schedules irrigation based on the relationship between the applied irrigation water depth (IW) and cumulative pan evaporation (CPE) to match crop water needs during specific growth stages.

Solution:

Let's calculate the target cumulative pan evaporation threshold step-by-step:

(a) State the standard climatological ratio formula:

$$\frac{\text{IW}}{\text{CPE}} = \text{Target Ratio}$$

(b) Identify the given parameters: Fixed Irrigation Depth (IW = 60 mm) and Target Ratio Threshold = 0.80.

(c) Rearrange the formula to solve for the target cumulative pan evaporation (CPE):

$$\text{CPE} = \frac{\text{IW}}{\text{Target Ratio}}$$

$$\text{CPE} = \frac{60 \text{ mm}}{0.80} = 75 \text{ mm}$$

This means irrigation should be applied as soon as the evaporimeter records a cumulative loss of 75 mm since the last watering.

Final Answer: $\boxed{75 \text{ mm}}$

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept: Micro-irrigation systems use emitters to deliver uniform water amounts. Online pressure-compensating (PC) emitters feature a flexible internal diaphragm that deforms under changing line pressures to maintain a stable discharge rate across a wide range of operating pressures.

Solution:

Let's evaluate the performance of a pressure-compensating emitter during a pressure spike:

(a) For standard non-compensating emitters, flow rate increases with pressure according to the relationship $Q = k \cdot P^x$ (where $x \approx 0.5$).

(b) For true **pressure-compensating emitters**, the design exponent value is near zero ($x \approx 0$). This means that within its rated operating range, changes in pressure do not significantly alter the discharge rate.

(c) Therefore, when the operating pressure rises from 1.5 bar to 2.5 bar, the diaphragm adjusts to keep the theoretical discharge rate stable at its calibrated flow of **4.0 L/h**.

Final Answer: $\boxed{\text{4.0 L/h}}$

$\boxed{\textbf{Answer: (A)}}$

Go Back to Question 18

Q19.

Solution

Concept: Hooghoudt's steady-state drainage equation determines the spacing (S) between parallel subsurface drains based on the soil's hydraulic conductivity (K), water table height, and the target drainage discharge rate.

Solution:

Let's analyze the mathematical relationship between spacing and hydraulic conductivity:

(a) Review the simplified form of Hooghoudt's equation, which relates spacing to hydraulic conductivity:

$$S^2 \propto K \implies S \propto \sqrt{K}$$

(b) If natural structural fracturing doubles the hydraulic conductivity of the water-bearing strata ($K_{new} = 2K$), substitute this change into the proportionality:

$$S_{new} \propto \sqrt{2K} = \sqrt{2} \times \sqrt{K} \approx 1.41 \times S$$

(c) This demonstrates that as the soil's water-transmitting capacity increases, the required drain spacing can scale up by a factor of **$\sqrt{2}$** ($\approx 1.41 \times S$) while maintaining the same water table drawdown rate, which reduces the total number of drain lines needed.

Final Answer: $\boxed{\text{Spacing scales up by a factor of exactly } \sqrt{2} \ (\approx 1.41 \times S)}$

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 19

Q20.

Solution

Concept: Total soil water potential (ψ_t) determines the energy status and direction of water movement through the soil-plant-atmosphere continuum. In unsaturated soils, water movement is driven by capillary and surface adhesion forces, as well as solute concentrations.

Solution:

Let's identify the dominant potentials operating in an unsaturated, saline rhizosphere:

(a) In unsaturated soils, gravitational potential (ψ_g) is minimal compared to retention forces, and hydrostatic pressure potential (ψ_p) applies only to saturated conditions.

(b) The primary water-retention mechanism in an unsaturated soil matrix is **matric potential (ψ_m)**, which binds water within small pores and around soil particles.

(c) At the same time, high salt concentrations generate a steep **osmotic potential (ψ_s)** gradient that opposes water uptake by root cells. To extract water under active transpiration pull, the plant must generate lower water potentials within the root xylem to overcome these combined matric and osmotic retention forces.

Final Answer: High Matrix potential (ψ_m) operating against a steep Osmotic potential (ψ_s) gradient.

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept: The Net Irrigation Requirement (NIR) calculates the depth of irrigation water needed to satisfy crop consumptive use after accounting for natural inputs like rainfall and pre-existing soil moisture reserves.

Solution:

Let's calculate the NIR step-by-step using the water balance equation:

(a) State the standard hydrological equation for net irrigation requirement:

$$\text{NIR} = \text{CU} - (\text{R}_e + \Delta\text{W})$$

(b) Identify the given metrics from the field data: Consumptive Use ($\text{CU} = 450$ mm), Effective Rainfall ($\text{R}_e = 50$ mm), and soil moisture contribution ($\Delta\text{W} = 20$ mm).

(c) Substitute these values into the equation:

$$\text{NIR} = 450\text{ mm} - (50\text{ mm} + 20\text{ mm}) = 450\text{ mm} - 70\text{ mm} = 380\text{ mm}$$

Final Answer: $\boxed{380\text{ mm}}$

Answer: (C)

Go Back to Question 21

Q22.

Solution

Concept: Herbicide resistance can evolve in weed populations through frequent exposure to a single chemical class. This selection pressure can lead to target-site mutations or enhanced metabolic detoxification systems that break down the herbicide before it reaches its target site.

Solution:

Let's review the biochemical mechanism of resistance in *Phalaris minor* against isoproturon:

(a) Isoproturon is a phenylurea herbicide that inhibits photosynthesis by binding to the D1 protein in photosystem II.

(b) Resistant biotypes of *Phalaris minor* found in continuous rice-wheat rotations do not typically exhibit a target-site mutation.

(c) Instead, resistance is driven by non-target-site **metabolic detoxification**. This is mediated by a hyper-activation of **Cytochrome P450 monooxygenase enzymes**, which rapidly metabolize and neutralize the isoproturon molecule within the plant tissues, allowing the weed to survive standard field applications.

Final Answer: Cytochrome P450 monooxygenases mediated detoxifying metabolism

Answer: (B)

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Q23.

Solution

Concept: Reflecting-type antitranspirants are materials applied to crop foliage to form a light-colored coating. This coating increases the leaf's reflectivity (albedo), lowering canopy temperature and transpiration losses without completely halting carbon dioxide assimilation.

Solution:

Let's classify the different types of antitranspirant materials:

(a) Phenyl Mercuric Acetate (PMA) acts as a chemical stomatal-closing agent.

(b) Liquid paraffin and polyethylene formulations form thin physical films over stomatal pores.

(c) **Kaolin clay emulsion (5 – 6%)** is a mineral compound that acts as a **reflecting-type antitranspirant**. When sprayed onto leaves, it leaves a white residue that reflects excess solar radiation. This lowers leaf temperature and reduces the vapor pressure gradient driving transpiration, helping conserve water during drought periods.

Final Answer: Kaolin clay emulsion (5 – 6%)

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept: To calculate the total commercial formulation required for a field, the recommended active ingredient (a.i.) rate per hectare is multiplied by the total field area and adjusted for the active ingredient concentration (purity) of the commercial product.

Solution:

Let's calculate the commercial quantity of Atrazine 50% WP step-by-step:

(a) Determine the total mass of active ingredient needed for the entire experimental block:

$$\text{Total active ingredient} = \text{Dose Rate} \times \text{Field Area} = 1.25 \text{ kg a.i./ha} \times 2.4 \text{ ha} = 3.0 \text{ kg a.i.}$$

(b) Account for the product's active ingredient concentration (50% Wettable Powder = 0.50) to find the total weight of the commercial product required:

$$\text{Commercial Quantity} = \frac{\text{Total active ingredient}}{\text{Formulation Concentration}} = \frac{3.0 \text{ kg a.i.}}{0.50} = 6.0 \text{ kg}$$

Final Answer: $\boxed{6.0 \text{ kg}}$

$\boxed{\textbf{Answer: (C)}}$

Go Back to Question 24

Q25.

Solution

Concept: Drought tolerance in minor millets involves coordinated morphological and biochemical adaptations that allow the plants to withstand tissue dehydration during extended dry spells and recover quickly once moisture becomes available.

Solution:

Let's evaluate the drought survival adaptations of Finger Millet (*Eleusine coracana*):

(a) Finger millet utilizes a highly efficient C_4 photosynthetic pathway, rather than a C_3 framework.

(b) Under severe moisture stress, it accumulates high levels of osmolytes, such as **proline**, within its cells. This accumulation helps maintain osmotic balance and protects cellular proteins from desiccation.

(c) This biochemical response is supported by **deep seminal root systems** that extract water from deeper soil profiles and **thick silicified cuticular layers** that limit non-stomatal water loss, enabling the crop to survive dry spells and resume growth after rain.

Final Answer: $\boxed{\text{High proline accumulation paired with deep seminal roots and thick silicified cuticular layers}}$

$\boxed{\textbf{Answer: (A)}}$

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	C	4	B	5	B
6	B	7	B	8	A	9	B	10	A
11	C	12	A	13	C	14	C	15	C
16	B	17	C	18	A	19	C	20	B
21	C	22	B	23	B	24	C	25	A