UPCATET Agronomy Sample Paper-6

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 high-yielding variety of deepwater rice (*Oryza sativa*) is cultivated in the flood-prone plains of Eastern Uttar Pradesh. During sudden submergence, the plant exhibits rapid internodal elongation driven by internal gas dynamics. Identify the specific phytohormone pathway trigger and the primary gaseous accumulation responsible for this deepwater survival mechanism.

(A) Downregulation of Abscisic Acid (ABA) leading to massive accumulation of Ethylene.

(B) Upregulation of Cytokinin leading to localized synthesis of Jasmonic Acid.

(C) Inhibition of Gibberellic Acid (GA_3) coupled with Methane trapping.

(D) Activation of Auxin transport pathways accompanied by Oxygen deficiency stress alone.

Q2. An agronomist calculates the theoretical plant population for a newly released bold-seeded chickpea (*Cicer arietinum*) variety targeted for the Bundelkhand region of UP. If the desired test weight (1000-seed weight) is 400 grams, the target plant density is 33 plants per square meter, and the certified seed lot has a germination percentage of 90% with a purity percentage of 95%, calculate the precise seed rate required per hectare.

(A) 132.0 kg/ha

(B) 154.4 kg/ha

(C) 112.8 kg/ha

(D) 144.2 kg/ha

Q3. In the industrial processing of sugarcane (*Saccharum officinarum*) in Western Uttar Pradesh, the maturity of the standing crop is assessed using a hand refractometer. At the point of peak physiological maturity (optimum sucrose synthesis), what should be the ideal Brix reading, and what specific glucose-to-sucrose ratio indicates that inversion has not yet degraded the quality?

(A) Brix reading of 10–12

(B) Brix reading of 18–20

(C) Brix reading of 14–16

(D) Brix reading of 22–25

Q4. During the physiological development of Brassica oilseeds (*Brassica juncea*), the biosynthesis of erucic acid and glucosinolates acts as a major quality determinant. To satisfy export-quality 'Double Zero' (Canola quality) specifications, what are the maximum permissible thresholds for erucic acid in oil and glucosinolates in defatted cake respectively?

(A) $< 2\%$ erucic acid and < 30 micromoles per gram glucosinolates

(B) $< 5\%$ erucic acid and < 60 micromoles per gram glucosinolates

(C) 0% erucic acid and < 10 micromoles per gram glucosinolates

(D) $< 10\%$ erucic acid and < 100 micromoles per gram glucosinolates

Q5. The physiological phenomenon of 'pop-up' or 'blind pods' in groundnut (*Arachis hypogaea*) cultivated in light-textured soils of Rohilkhand results in severe yield loss. This condition, characterized by fully expanded pods completely lacking kernels, is fundamentally caused by the deficiency of which nutrient at which specific developmental stage?

(A) Nitrogen deficiency during the early vegetative phase

(B) Zinc deficiency during the lateral branching stage

(C) Calcium deficiency during the pegging and pod-development zone phase

(D) Boron deficiency exclusively during the seedling emergence phase

Q6. A physiological disorder known as 'buttoning' in cauliflower and 'lodging-induced chaffiness' in cereal crops like wheat are frequently monitored. If a wheat crop in Central UP displays an abrupt breaking of the lowest culm internodes under a moderate wind velocity of 15 km/h, which nutritional imbalance and physiological cell wall component deficiency is directly responsible?

(A) Excessive Potassium fertilization leading to thin cellulose deposition

(B) Excessive Nitrogen application combined with low Potassium, reducing lignin synthesis in the cell wall

(C) Acute Phosphorus deficiency hindering the structural integrity of phospholipids

(D) Severe Magnesium toxicity blocking the formation of calcium pectate in the middle lamella

Q7. Consider the modern physiological classification of Pigeonpea (*Cajanus cajan*) varieties. Ultra-short duration varieties (e.g., ICPL 88039) escape terminal drought in semi-arid zones of UP. What is the precise photoperiodic nature and base temperature (T_b) requirement of these new genotypes compared to traditional long-duration types?

(A) Strictly long-day photoperiod system with a base temperature of 5°C

(A) Quantitative short-day or photoperiod-insensitive nature with a base temperature of around 10°C

(A) Obligate long-day nature with a high base temperature requirement of 18°C

(A) Amphiphilic photoperiod nature with a fluctuating base temperature of 0°C

Q8. The critical growth stages of Maize (*Zea mays*) dictate its definitive yield architecture. If a moisture stress event occurs precisely during the transition between the V18 stage and the R1 stage, which component of the yield layout suffers the most drastic irreversible damage?

(A) Number of potential rows per ear due to lack of differentiation

(B) Kernel numbers per row due to poor anthesis-silking interval (ASI) synchronization

(C) Initial seedling coleoptile elongation rate

(D) Theoretical weight of the structural husk cover

Q9. During the curing process of Flue-Cured Virginia (FCV) tobacco, complex biochemical alterations transform green leaves into high-grade golden yellow leaf tissue. Identify the correct sequential chemical transformation that must occur during the yellowing phase of curing:

(A) Complete starch hydrolysis into reducing sugars followed by slow chlorophyll degradation under high humidity.

(B) Rapid chlorophyll degradation coupled with enzymatic conversion of starch to reducing sugars under controlled temperature (35–40°C)$and 80\breve{}85\% relative humid$

(B) Conversion of nicotine into nornicotine via oxidative volatilization at 70°C.

(C) Fixed denaturation of proteins into free ammonia gas under dry air currents.

Q10. A farmer performs late-sown wheat cultivation following sugarcane harvest in Western UP. To compensate for the shortened vegetative growth period and lower thermal unit accumulation (Growing Degree Days), what modification must be made to the seed rate and row spacing configuration?

(A) Decrease seed rate by 25% and increase row spacing to 25 cm

(B) Keep seed rate constant at 100 kg/ha and expand row spacing to 30 cm

(C) Increase seed rate by 25% (up to 125–150 kg/ha) and narrow down row spacing to 15–18 cm

(D) Reduce seed rate to 75 kg/ha and adopt a cross-sowing geometry at 22.5 cm

Q11. In the vast Indo-Gangetic plains of Uttar Pradesh, 'Usar' or salt-affected soils pose a severe structural and chemical challenge. If a soil sample extracted from Mainpuri district shows an Electrical Conductivity (EC_e) of 3.5 dS/m at

25°C, an Exchangeable Sodium Percentage (ESP) of 22%, and a pH of 9.1, how should this soil be classified, and what chemical amendment is mandatory for its reclamation?

(A) Saline soil; requires heavy leaching with pure water only

(B) Alkali / Sodic soil; requires application of Calcium Sulfate (Gypsum, $CaSO_4 \cdot 2H_2O$)

(C) Saline-Alkali soil; requires application of elemental Sulfur followed by lime

(D) Acidic soil; requires application of Calcium Carbonate ($CaCO_3$)

Q12. The physical mechanics of wind erosion follow a distinct particle size distribution layout. During a massive pre-monsoon dust storm in the semi-arid tract of Agra, particles ranging from 0.1 mm to 0.5 mm in diameter move across the fields in a series of short bounces. What is this specific mode of transport called, and what percentage of total wind erosion does it typically account for?

(A) Suspension; accounts for less than 10% of total soil movement

(B) Surface creep; accounts for 50–70% of total soil movement

(C) Saltation; accounts for 50–75% of total soil movement

(D) Detrusion; accounts for exactly 95% of total soil movement

Q13. A specialized secondary tillage operation known as 'puddling' is executed in rice fields across Eastern UP to create an impermeable layer that prevents deep percolation. At a micro-structural level, what physical changes occur to the soil bulk density and the total pore space distribution within the puddled zone (0 to 15 cm depth) immediately after the operation stabilizes?

(A) Complete destruction of non-capillary macropores, increase in capillary micropores, and a transient increase in bulk density of the lower plow pan.

(B) Massive increase in macropores, leading to an overall reduction in capillary action.

(C) Uniform drop in bulk density to 0.5 g/cm^3 with zero change in pore configuration.

(D) Total aggregation of clay into stable sand-sized structures.

Q14. The structural stability of soils in the Vindhyan region of UP is heavily dependent on the type of clay mineral dominant in the matrix. If a soil is characterized by a 2:1 expanding crystal lattice type mineral with high cation exchange capacity (80 to 150 meq/100g), severe cracking during summer, and a high coefficient of linear extensibility (COLE), identify the dominant clay mineral and the matching USDA soil order.

(A) Kaolinite; Oxisols

(B) Illite; Inceptisols

(C) Montmorillonite; Vertisols

(D) Gibbsite; Alfisols

Q15. An agronomist is studying 'Conservation Agriculture' systems in the rice-wheat cropping sequence of Central UP. Under a strict continuous zero-tillage (No-Till) management system maintained for 8 consecutive years, how do the organic carbon concentration gradients and the steady-state water infiltration rates change compared to a conventional clean tillage system?

(A) Organic carbon becomes uniformly distributed down to 60 cm depth, and infiltration rates decrease continuously.

(B) Organic carbon stratifies heavily near the surface (0 to 5 cm zone), and macro-infiltration rates increase due to preserved earthworm channels and continuous macropores.

(C) Total elimination of organic carbon from the topsoil layer occurs alongside an increase in surface crusting.

(D) Surface organic carbon decreases drastically, causing a sudden collapse of steady-state infiltration.

Q16. Universal Soil Loss Equation (USLE) is formulated as $A = R \times K \times L \times S \times C \times P$. If a watershed manager in the ravines of the Yamuna river system installs contour bunding combined with strip cropping across a 4-degree slope, which specific parameters of the USLE are directly manipulated to minimize the computed soil loss value (A)?

(A) R (Rainfall erosivity index) and K (Soil erodibility factor)

(B) Only L (Slope length factor) and S (Slope steepness factor)

(C) C (Crop management factor) and P (Support practice factor)

(D) The product of $R \times K$ exclusively, leaving other factors untouched

Q17. A precise irrigation scheduling experiment is conducted using a Tensiometer installed at the root zone of a potato crop in Farrukhabad, UP. If the gauge of the tensiometer registers a soil moisture tension reading of 65 cb (centibars), what does this value signify regarding soil water availability, and can a standard tensiometer be utilized effectively if the tension drops to 150 cb (1.5 bars)?

(A) It signifies that the soil is at field capacity; yes, tensiometers operate efficiently up to 150 cb.

(B) It signifies that about 50–60% of available water is depleted in coarse/medium soils; no, tensiometers break down due to air entry (cavitation) beyond 80 to 85 cb.

(C) It indicates absolute permanent wilting point; yes, because tensiometers function linearly from 0 to 15 bars.

(D) It implies a saturated soil matrix with zero oxygen; no, tensiometers only operate in completely dry desert soils.

Q18. Calculate the total depth of irrigation water required (IR) for a crop of wheat if the total Consumptive Use (CU) or Evapotranspiration (ET_c) over the growth cycle is 450 mm, effective rainfall received during the season (ER) is 50 mm, and the overall water application efficiency of the surface flooding system is 60%. (Assume deep percolation losses below the root zone are the only losses accounted for by efficiency parameters).

(A) 400 mm

(B) 666.67 mm

(C) 240 mm

(D) 750 mm

Q19. In pressurized micro-irrigation layout designs, 'Drip Irrigation' emitter discharge rates must be matched to soil hydraulic conductivity. If an orchard in the semi-arid plain of UP features an average steady-state clay-loam infiltration rate of 8 mm/hour and a tree spacing layout of 5 m $\times$ 5 m, what happens if emitters with an excessive discharge rate of 16 L/hour per emitter are installed over a confined wetting radius of 0.5 meters?

(A) Excellent localized deep storage with zero localized evaporation.

(B) Generation of localized surface ponding and runoff because the application rate within the wetting zone exceeds the soil's saturated hydraulic conductivity.

(C) Instant transformation of clay loam into a structured sandy profile.

(D) Linear increase in the capillary rise from the deep water table.

Q20. Agricultural drainage systems are vital for mitigating waterlogging in the low-lying Terai belt of UP. If a subsurface tile drainage system is being designed to lower a perched water table, according to Hooghoudt's equation, how does the required spacing (S) between parallel underground tile drains change relative to the drainage coefficient (q) and the hydraulic conductivity (K) of the soil layer?

(A) Drain spacing (S) is directly proportional to the drainage coefficient (q).

(B) Drain spacing (S) is inversely proportional to the square root of the drainage coefficient (q) and directly proportional to the square root of hydraulic conductivity (K).

(C) Spacing is entirely independent of soil hydraulic conductivity variations.

(D) Spacing values decrease linearly as the hydraulic conductivity increases.

Q21. The critical evaluation of irrigation water quality involves checking the Sodium Adsorption Ratio (SAR). If a deep tubewell water sample from a block in Mathura reveals analytical concentrations of Na^+ = 18 meq/L, Ca^{2+} = 4 meq/L, and Mg^{2+} = 4 meq/L, calculate the exact SAR value of this irrigation water and predict its hazard class.

(A) $SAR = 4.5$; Low Sodium Hazard class

(B) $SAR = 9.0$; Medium Sodium Hazard class

(C) $SAR = 12.73$; High Sodium Hazard class

(D) $SAR = 18.0$; Very High Sodium Hazard class

Q22. The biochemical mechanism of herbicide selectivity is highly complex. A wheat field in Western UP is heavily infested with *Phalaris minor* (Little seed canary grass) that has developed cross-resistance to isoproturon. When substituting with the advanced herbicide Clodinafop-propargyl, what is the precise biochemical target enzyme inhibited in the weed, and why does the wheat crop remain completely undamaged?

(A) Inhibits Acetolactate Synthase (ALS); wheat metabolizes it via cytochrome P450 monooxygenases.

(B) Inhibits Acetyl-CoA Carboxylase (ACCase); wheat survives due to rapid metabolic detoxification mediated by the co-applied safener cloquintocet-mexyl.

(C) Disrupts Photosystem II complex; wheat has modified chloroplast binding sites that prevent attachment.

(D) Blocks 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase; wheat naturally overproduces this enzyme.

Q23. In dryland agricultural tracts of Bundelkhand, crop plants survive extended dry spells via distinct physiological adaptation pathways categorized by 'Dehydration Avoidance' and 'Dehydration Tolerance'. Which of the following suites of physiological traits is a classic manifestation of a true metabolic dehydration tolerance mechanism rather than mere avoidance?

(A) Development of thick cuticular wax layers, rapid stomatal closure, and deep taproot systems.

(B) Leaf rolling, reduction in total leaf area index, and short life cycles (ephemerals).

(C) Cellular accumulation of compatible osmoprotectants (like proline and glycine betaine) along with upregulation of Late Embryogenesis Abundant (LEA) structural proteins.

(D) Heliotropic leaf movements that track the sun to minimize interception.

Q24. The concept of 'Moisture Conservation Index' in dryland farming involves utilizing synthetic antitranspirants. If a dryland sorghum crop facing terminal dry spells is sprayed with a 'Stomatal Closing' type antitranspirant and a 'Reflecting' type antitranspirant respectively, identify the correct pair of chemicals that match these descriptions perfectly:

(A) Phenyl Mercuric Acetate (PMA) as a stomatal closer; Kaolin (6–10%) as a reflecting type.

(B) Atrazine as a reflecting type; Liquid Paraffin as a stomatal closer.

(C) Kaolin as a stomatal closer; Mobilaf as a cellular metabolic block.

(D) Cycocel (CCC) as a growth promoter; Silicons as reflection agents.

Q25. Weed-crop competition dynamics follow the 'Critical Period of Weed Competition' (CPWC). In a direct-seeded rice (DSR) system cultivated under dryland conditions in Eastern UP, what is the precise chronological span of the CPWC during which the crop must be kept weed-free to prevent a drastic yield collapse exceeding 50%?

(A) From 0 to 10 days after sowing (only seedling emergence phase).

(B) From 15 to 45 days after sowing (corresponding to peak active tillering phase).

(C) From 70 to 90 days after sowing (during panicle initiation to grain filling).

(D) Strictly during the post-harvest storage period to prevent contamination.

Detailed Solutions

Q1.

Solution

Concept: Deepwater rice varieties survive sudden, prolonged flooding through a specialized escape mechanism characterized by rapid internodal elongation. This rapid stem growth keeps the upper leaves and panicle above the rising water surface, allowing the plant to maintain respiration and photosynthesis.

Solution:

Let's analyze the physiological and hormonal sequence triggered by submergence:

(a) When plants are submerged, gas diffusion is severely restricted. This causes **ethylene**, a gaseous plant hormone synthesized by the tissue, to become trapped and **accumulate heavily** inside the submerged plant parts.

(b) The high concentration of ethylene triggers a drastic **downregulation of Abscisic Acid (ABA)**, which is a potent growth inhibitor.

(c) The drop in ABA levels removes the brake on plant growth and stimulates the synthesis and sensitivity of Gibberellic Acid (GA). This hormonal shift accelerates cell division and elongation in the intercalary meristems of the internodes, allowing the plant to rapidly extend above the water.

Final Answer: $\boxed{\text{Downregulation of Abscisic Acid (ABA) leading to massive accumulation of Ethylene.}}$

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept: The agronomic seed rate calculation establishes the gross quantity of seed needed per hectare based on a target plant density, seed size (test weight), and the seed lot's Real Value (or Utility Value). The Real Value adjusts the raw seed rate to account for non-viable seeds and physical impurities.

Solution:

Let's calculate the required seed rate step-by-step using the standard agronomic approach:

(a) Find the weight of an individual seed from the given test weight (1000-seed weight = 400 g):

$$\text{Weight per seed} = \frac{400 \text{ g}}{1000} = 0.4 \text{ g} = 0.0004 \text{ kg}$$

(b) Determine the target number of plants per hectare (1 ha = $10,000 \text{ m}^2$):

$$\text{Target Population} = 33 \text{ plants/m}^2 \times 10,000 \text{ m}^2/\text{ha} = 330,000 \text{ plants/ha}$$

(c) Calculate the absolute theoretical seed weight required per hectare assuming 100% survival:

$$\text{Theoretical Seed Weight} = 330,000 \times 0.0004 \text{ kg} = 132.0 \text{ kg/ha}$$

(d) Calculate the Real Value (RV) coefficient using the germination percentage (90% = 0.90) and physical purity percentage (95% = 0.95):

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

(e) Divide the theoretical seed weight by the Real Value to find the true physiological seed rate:

$$\text{Precise Seed Rate} = \frac{132.0 \text{ kg/ha}}{0.855} \approx 154.4 \text{ kg/ha}$$

Final Answer: $\boxed{154.4 \text{ kg/ha}}$

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: Sugarcane maturity testing determines when sucrose accumulation in the stalks peaks. Producers monitor both total dissolved solids (Brix percentage) and the composition of internal sugars to ensure high processing efficiency and avoid quality losses from chemical inversion.

Solution:

Let's analyze the biochemical indices at optimal crop maturity:

(a) A hand refractometer measures the juice's total soluble solids. At peak physiological maturity, a high-quality standing crop exhibits an **ideal Brix reading of 18–20%**.

(b) Inversion is a damaging process where complex sucrose splits into simple reducing sugars (glucose and fructose) due to maturity imbalances, frost, or delayed processing.

(c) To ensure that inversion has not degraded the raw juice quality, the **glucose-to-sucrose ratio must remain low (less than 0.5)**. A higher ratio indicates that accumulated sucrose is actively breaking down, which reduces crystal recovery at the mill.

Final Answer: $\boxed{\text{Brix reading of 18–20\% with a glucose ratio less than 0.5}}$

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept: Export-quality oilseed mustard must meet strict international biochemical standards, often referred to as 'Double Zero' or 'Canola' specifications. These standards restrict two anti-nutritional compounds: erucic acid in the extracted oil and glucosinolates in the residual meal cake.

Solution:

Let's identify the maximum allowable thresholds for these target components:

(a) Eruic acid is a monounsaturated fatty acid linked to cardiovascular concerns when consumed in large quantities. The 'Double Zero' standard requires the erucic acid content in the oil to be **less than 2%** of total fatty acids.

(b) Glucosinolates are sulfur-rich compounds that impart a bitter flavor and can cause thyroid dysfunctions in livestock when present in the meal. The standard limits glucosinolate concentrations in the defatted meal cake to **less than 30 micromoles per gram**.

Final Answer: $\boxed{< 2\% \text{ erucic acid and } < 30 \text{ micromoles per gram glucosinolates}}$

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept: 'Pop-up' or 'blind pods' is a physiological disorder in groundnut where the outer shell develops normally below ground, but the internal kernels fail to form, resulting in empty pods and severe yield losses.

Solution:

Let's look at the nutrient uptake mechanics of developing groundnut pods:

(a) Calcium is an immobile element in the phloem tissue, meaning it cannot translocate downward from the leaves into the underground fruiting structures.

(b) Consequently, developing pegs and pods must absorb calcium directly from the surrounding soil matrix via cell wall diffusion during the **pegging and pod-development zone phase**.

(c) If the shallow soil zone lacks sufficient **ionic calcium (Ca^{2+})**, the plant cannot complete embryo cell division and seed development, leading to empty "blind" pods.

Final Answer: Calcium deficiency during the pegging and pod-development zone phase

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: Lodging in cereal crops is a structural failure where stalks break or bend under environmental forces like wind or rain. The mechanical strength of the lower culm internodes is determined by the composition and thickness of their structural cell walls.

Solution:

Let's evaluate how nutrient imbalances alter cell wall development:

(a) High applications of nitrogen promote rapid vegetative growth, leading to elongated cells with thin, flexible walls.

(b) Potassium (K) acts as a primary catalyst for carbohydrate synthesis, cellulose deposition, and **lignin polymerization** within the sclerenchyma tissues of the stem.

(c) When a crop receives **excessive nitrogen combined with low potassium**, lignin synthesis decreases. This leaves the lower internodes structurally weak and susceptible to snapping or collapsing under moderate wind velocities.

Final Answer: Excessive Nitrogen application combined with low Potassium, reducing lignin synthesis in the cell wall

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Modern ultra-short duration pigeonpea cultivars are bred to fit into intensive crop rotations and escape terminal drought by completing their life cycle quickly. This adaptation requires modifications to their photoperiodic sensitivity and thermal requirements.

Solution:

Let's evaluate the characteristics of these modern genotypes:

(a) Traditional long-duration pigeonpea varieties are obligate short-day plants that require specific photoperiod signals to trigger flowering, which extends their growth cycle.

(b) Modern ultra-short duration genotypes (like ICPL 88039) are bred to be **quantitative short-day or photoperiod-insensitive**. This allows them to transition to reproductive growth regardless of day length, reducing their vegetative duration.

(c) These varieties maintain a standard tropical legume developmental **base temperature (T_b) requirement of around 10°C**, below which their thermal unit accumulation stops.

Final Answer: Quantitative short-day or photoperiod-insensitive nature with a base temperature of around 10°C.

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: The impact of moisture stress on maize yield varies across its growth stages. The transition from late vegetative growth (V18) to early reproductive growth (R1, silking) is highly vulnerable because it directly affects pollination and kernel set.

Solution:

Let's trace how moisture stress at the V18–R1 transition affects yield components:

(a) The number of potential kernel rows per ear is determined early in the vegetative phase (around V6 to V8) and is not affected by late-stage stress.

(b) During the V18 to R1 transition, the plant coordinates tassel development and silk elongation.

(c) Moisture stress at this stage slows silk elongation, while tassel development continues normally. This increases the **anthesis-silking interval (ASI)**. A wide ASI means pollen sheds before the cobs' silks are fully exposed, leading to poor fertilization and a drastic, irreversible reduction in **kernel numbers per row**.

Final Answer: Kernel numbers per row due to poor anthesis-silking interval (ASI) synchronization

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept: Flue-Curing Virginia (FCV) tobacco involves a multi-stage thermal process (yellowing, color-fixing, leaf-drying, and stem-drying) that regulates biochemical transformations to optimize leaf color, sugar content, and aroma.

Solution:

Let's examine the chemical changes required during the initial yellowing phase:

(a) The yellowing phase focuses on degrading green pigments while managing internal moisture loss so the leaf cells remain alive during enzymatic breakdown.

(b) This is achieved by maintaining a controlled temperature of **35–40°C*withahighrelativehumidityof*80˜85% * *.

(b) Under these conditions, starches rapidly convert into reducing sugars, and chlorophyll breaks down to reveal the underlying yellow carotenoid pigments, establishing the desired golden-yellow leaf quality.

Final Answer: Rapid chlorophyll degradation coupled with enzymatic conversion of starch to reducing sugars under controlled temperature (35–40°C) and 80–85% relative humidity.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Late-sown wheat crops face a shortened vegetative growth window because rising spring temperatures induce early flowering. This reduces the crop's total Growing Degree Days (GDD) and limits its natural tillering capacity.

Solution:

Let's identify the agronomic adjustments needed for late-sown conditions:

(a) Because individual plants have less time to produce synchronous tillers, growers must increase initial plant populations to maintain an adequate number of spikes per unit area. This is achieved by **increasing the seed rate by 25%** (raising it from 100 kg/ha up to **125–150 kg/ha**).

(b) At the same time, **narrowing the row spacing to 15–18 cm** (down from the standard 22.5 cm) ensures more uniform ground cover. This optimization helps the dense plant population maximize light interception and resources within the shortened growing season.

Final Answer: Increase seed rate by 25% (up to 125–150 kg/ha) and narrow down row spacing to 15–18 cm

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept: Salt-affected soils are classified into saline, sodic (alkali), or saline-sodic categories based on three analytical criteria: Electrical Conductivity (EC_e), Exchangeable Sodium Percentage (ESP), and pH.

Solution:

Let's evaluate the given soil metrics to determine its classification and reclamation needs:

(a) The soil sample from Mainpuri shows an $EC_e = 3.5$ dS/m (which is < 4.0 dS/m), an $ESP = 22\%$ (which is $> 15\%$), and a pH $= 9.1$ (which is > 8.5).

(b) This combination of low soluble salts ($EC_e < 4$) and a high sodium saturation on the exchange complex ($ESP > 15\%$, pH > 8.5) classifies the sample as an **Alkali / Sodic soil**.

(c) Reclaiming sodic soil requires a chemical amendment that supplies divalent calcium to displace exchangeable sodium. Incorporating agricultural **Gypsum ($CaSO_4 \cdot 2H_2O$)** provides soluble calcium (Ca^{2+}) that replaces adsorbed Na^+ ions, converting them into soluble sodium sulfate (Na_2SO_4) which can then be leached out of the root zone.

Final Answer: Alkali/Sodic soil; requires application of Calcium Sulfate (Gypsum, $CaSO_4 \cdot 2H_2O$).

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: Wind erosion moves soil particles through three physical mechanisms—suspension, saltation, and surface creep—depending on wind velocity and the aerodynamic diameter of the soil particles.

Solution:

Let's analyze particle movement within the 0.1 mm to 0.5 mm size range:

(a) Particles smaller than 0.1 mm are lifted into the atmosphere and remain suspended over long distances (Suspension). Particles larger than 0.5 mm roll along the ground surface (Surface Creep).

(b) Intermediate particles ranging from **0.1 mm to 0.5 mm** move via **Saltation**. These fine sand grains are lifted briefly by wind energy before bouncing back to the ground.

(c) Saltation is the dominant mechanism in wind erosion, accounting for **50–75% of total soil movement** and triggering additional erosion when bouncing particles impact the soil surface.

Final Answer: $\boxed{\text{Saltation; accounts for 50–75\% of total soil movement}}$

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

Go Back to Question 12

Q13.

Solution

Concept: Puddling is a wet-tillage practice used in rice cultivation that shatters soil aggregates into a structured paste, altering the soil's physical properties to reduce water losses from deep percolation.

Solution:

Let's look at the physical changes that occur in the puddled layer:

(a) Mechanical plowing of saturated soil breaks down structural macro-aggregates into individual clay and silt particles.

(b) This collapse causes a **complete destruction of non-capillary macropores** and a corresponding **increase in capillary micropores**.

(c) The displaced clay particles settle into a dense layer just below the tilled zone, creating a **transient increase in bulk density of the lower plow pan**. This low-permeability boundary layer cuts down water percolation losses to help maintain standing water in the field.

Final Answer: $\boxed{\text{Complete destruction of non-capillary macropores, increase in capillary micropores, and a transient increase in bulk density of the lower plow pan.}}$

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

Go Back to Question 13

Q14.

Solution

Concept: Soil taxonomies categorize soils based on diagnostic horizons and dominant clay mineralogy, which directly influence properties like cation exchange capacity and volumetric moisture responses.

Solution:

Let's analyze the properties of the target soil matrix:

(a) The soil features a $2:1$ expanding crystal lattice clay with a high cation exchange capacity (80 to 150 meq/100g) and a high coefficient of linear extensibility (COLE).

(b) These characteristics are typical of **Montmorillonite**, a smectite-group clay mineral that expands when wet and contracts when dry. This extreme shrink-swell behavior creates deep vertical cracks during summer, which is the defining physical property of the USDA soil order **Vertisols**.

Final Answer: $\boxed{\text{Montmorillonite; Vertisols}}$

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

Go Back to Question 14

Q15.

Solution

Concept: Long-term zero-tillage (No-Till) practices alter the soil profile by eliminating mechanical inversion, which modifies organic matter distribution and the continuity of soil pores over time.

Solution:

Let's contrast a continuous 8-year zero-tillage system with conventional clean tillage:

(a) Without plowing to distribute crop residues throughout the profile, organic matter accumulates where it falls, leading to **heavy stratification near the surface (0 to 5 cm zone)**.

(b) Eliminating mechanical tillage preserves soil biological structures, such as **earthworm channels, root channels, and continuous macropores**, from year to year.

(c) These undisturbed, stable macro-channels open directly to the surface, increasing steady-state water infiltration rates compared to conventionally tilled soils where plow pans or surface crusts restrict flow.

Final Answer: $\boxed{\text{Organic carbon stratifies heavily near the surface (0 to 5 cm zone), and macro-infiltration rates increase due to preserved earthworm channels and continuous macropores.}}$

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

Go Back to Question 15

Q16.

Solution

Concept: The Universal Soil Loss Equation (USLE) isolates environmental and management parameters to estimate average annual soil erosion rates:

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

Solution:
Let's identify which factors change when installing contour bunds and practicing strip cropping:

(a) Climatic forces (R, rainfall erosivity) and inherent soil properties (K, soil erodibility) cannot be altered by these structural field installations. Similarly, the overall slope dimensions (L and S) are fixed by the natural landscape topography.

(b) **Strip cropping** alters the vegetative pattern and surface cover over time, which directly manipulates the **Crop management factor (C)**.

(c) **Contour bunding** is a mechanical erosion control practice that intercepts runoff. This installation modifies the **Support practice factor (P)**, lowering the overall calculated soil loss (A).

Final Answer: C (Crop management factor) and P (Support practice factor)

Answer: (C)

Go Back to Question 16

Q17.

Solution

Concept: Tensiometers measure the negative hydrostatic pressure (soil moisture tension) of water in unsaturated soils. Their effective operating range is limited by the physical properties of water under tension.

Solution:

Let's evaluate the significance and physical limits of a tensiometer reading:

(a) A soil moisture tension reading of **65 cb** indicates that the soil matrix has dried out significantly past field capacity (10 to 30 cb), meaning **about 50–60% of the available water has been depleted** in coarse- to medium-textured soils, making it a standard indicator to start irrigation.

(b) Tensiometers operate by establishing a continuous water column through a porous ceramic cup.

(c) When soil tension drops or dries out **beyond 80 to 85 cb (0.8 bar)**, the high tension pulls dissolved air out of solution, causing **cavitation** (air entry into the tube). This breaks the water column and causes the instrument to fail, meaning it cannot be used at 150 cb.

Final Answer: $\boxed{\text{It signifies that about 50–60\% of available water is depleted in coarse/medium soils; no, tensiometers break down due to air entry (cavitation) beyond 80 to 85 cb.}}$

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

Go Back to Question 17

Q18.

Solution

Concept: The total depth of irrigation water required (IR) accounts for both the net water depth needed by the crop (Net Irrigation Requirement, NIR) and the operational water losses that occur during field application, as determined by the system's application efficiency (E_a).

Solution:

Let's calculate the total required depth step-by-step:

(a) Calculate the Net Irrigation Requirement (NIR) by subtracting effective rainfall (ER = 50 mm) from total consumptive use (CU = 450 mm):

$$NIR = CU - ER = 450 \text{ mm} - 50 \text{ mm} = 400 \text{ mm}$$

(b) Adjust the net depth to account for application efficiency ($E_a = 60\% = 0.60$) to determine the total depth of water that must be delivered to the field:

$$IR = \frac{NIR}{E_a} = \frac{400 \text{ mm}}{0.60} = 666.67 \text{ mm}$$

Final Answer: $\boxed{666.67 \text{ mm}}$

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept: To prevent localized ponding and surface runoff in drip irrigation, the water application rate within the emitter's wetting zone must not exceed the soil's saturated hydraulic conductivity (infiltration rate).

Solution:

Let's calculate the localized water application rate within the wetting zone:

(a) Find the surface area of the circular wetting zone with a radius ($r = 0.5$ m):

$$\text{Area} = \pi \cdot r^2 = 3.1416 \times (0.5)^2 = 0.7854 \text{ m}^2$$

(b) Calculate the application rate by dividing the emitter discharge (16 L/hour) by this localized wetting area:

$$\text{Application Rate} = \frac{16 \text{ L/hour}}{0.7854 \text{ m}^2} \approx 20.37 \text{ L/(m}^2 \cdot \text{hour)} = 20.37 \text{ mm/hour}$$

(c) Compare this localized application rate (20.37 mm/hour) to the soil's steady-state infiltration rate (8 mm/hour). Because the water delivery rate significantly exceeds the soil's infiltration capacity, the soil cannot absorb the water fast enough, leading to **localized surface ponding and runoff** around the emitter base.

Final Answer: Generation of localized surface ponding and runoff because the application rate within the wetting zone exceeds the soil's saturated hydraulic conductivity.

Answer: (B)

Go Back to Question 19

Q20.

Solution

Concept: Hooghoudt's steady-state equation determines the spacing (S) between parallel subsurface drains based on the soil's hydraulic conductivity (K), the design water table depth, and the drainage coefficient (q, which represents the rate of water removal).

Solution:

Let's analyze the mathematical relationships in Hooghoudt's drainage formula:

(a) Review the simplified form of Hooghoudt's equation for drain spacing:

$$S^2 = \frac{8 \cdot K \cdot d \cdot h + 4 \cdot K \cdot h^2}{q}$$

(b) Isolate the drain spacing variable (S) to observe its relationship to hydraulic conductivity (K) and the drainage coefficient (q):

$$S = \sqrt{\frac{4 \cdot K \cdot h \cdot (2d + h)}{q}} \implies S \propto \frac{\sqrt{K}}{\sqrt{q}}$$

(c) This demonstrates that the required drain spacing (S) is **inversely proportional to the square root of the drainage coefficient ($\sqrt{q}$)** and **directly proportional to the square root of hydraulic conductivity ($\sqrt{K}$)**.

Final Answer: Drain spacing (S) is inversely proportional to the square root of the drainage coefficient (q) and directly proportional to the square root of hydraulic conductivity (K).

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept: The Sodium Adsorption Ratio (SAR) assesses the sodicity or relative sodium hazard of irrigation water by comparing the concentration of monovalent sodium (Na^+) ions to divalent calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions.

Solution:

Let's compute the SAR value step-by-step using the standard formula:

(a) State the analytical SAR equation (where ion concentrations are expressed in milliequivalents per liter, meq/L):

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}]+[Mg^{2+}]}{2}}}$$

(b) Substitute the given concentrations ($Na^+ = 18$, $Ca^{2+} = 4$, and $Mg^{2+} = 4$) into the equation:

$$SAR = \frac{18}{\sqrt{\frac{4+4}{2}}} = \frac{18}{\sqrt{\frac{8}{2}}} = \frac{18}{\sqrt{4}} = \frac{18}{2} = 9.0$$

(c) Classify the sodium hazard based on standard irrigation water guidelines: an SAR value between 0 and 10 falls into the **Medium Sodium Hazard class** (often designated as S1/S2 boundaries depending on conductivity), making $SAR = 9.0$ a medium hazard water.

Final Answer: $\boxed{SAR = 9.0\text{; Medium Sodium Hazard class}}$

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: Graminicide selectivity often exploits differences in biochemical target site sensitivity or relies on co-applied chemical safeners that accelerate herbicide metabolism exclusively within the crop tissues.

Solution:

Let's analyze the biochemical interaction of clodinafop-propargyl in wheat and grass weeds:

(a) Clodinafop-propargyl is an aryloxyphenoxypropionate herbicide that inhibits **Acetyl-CoA Carboxylase (ACCase)**, an enzyme essential for fatty acid synthesis in grass species.

(b) Both *Phalaris minor* and wheat possess ACCase enzymes that are naturally sensitive to this molecule.

(c) To protect the crop, commercial formulations include the chemical safener **cloquintocet-mexyl**. In wheat plants, this safener activates glutathione S-transferase and cytochrome P450 pathways, triggering **rapid metabolic detoxification** that neutralizes the herbicide before it can damage the crop, while the weed is killed.

Final Answer: Inhibits Acetyl-CoA Carboxylase (ACCase); wheat survives due to rapid metabolic detoxification mediated by the co-applied safener cloquintocet-mexyl.

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: Drought survival mechanisms in plants are broadly divided into 'Dehydration Avoidance' and 'Dehydration Tolerance'. Avoidance strategies use structural adaptations to maintain high tissue water potential during dry periods. Tolerance strategies use metabolic adaptations to protect cellular machinery when tissue water content drops.

Solution:

Let's evaluate the given suites of physiological traits:

(a) Wax layers, deep roots, leaf rolling, and short life cycles are classic avoidance mechanisms designed to limit transpiration or maximize water uptake to keep tissues hydrated.

(b) True metabolic **dehydration tolerance** involves biochemical adaptations that safeguard cell integrity when water is scarce.

(c) This is demonstrated by the **cellular accumulation of compatible osmoprotectants** (such as proline and glycine betaine), which maintain cellular turgor and stabilize macromolecules, along with the **upregulation of Late Embryogenesis Abundant (LEA) structural proteins** that protect cellular membranes from desiccation damage.

Final Answer: Cellular accumulation of compatible osmoprotectants (like proline and glycine betaine) along with upregulation of Late Embryogenesis Abundant (LEA) structural proteins.

Answer: (C)

Go Back to Question 23

Q24.

Solution

Concept: Antitranspirants are chemical compounds applied to foliage to limit transpiration losses. They are grouped by their mode of action: stomatal-closing types, film-forming types, reflecting types, or growth retardants.

Solution:

Let's match the chemical compounds to their correct functional descriptions:

(a) **Phenyl Mercuric Acetate (PMA)** (and low concentrations of atrazine) acts as a **stomatal-closing** antitranspirant by altering guard cell turgor to trigger partial closure.

(b) **Kaolin clay emulsion (6–10%)** is a mineral compound that acts as a **reflecting-type** antitranspirant. It coats the leaves with a white residue that increases albedo, lowering leaf temperature and reducing the vapor pressure gradient driving water loss.

Final Answer: Phenyl Mercuric Acetate (PMA) as a stomatal closer; Kaolin (6–10%) as a reflecting type.

Answer: (A)

Go Back to Question 24

Q25.

Solution

Concept: The Critical Period of Weed Competition (CPWC) is the growth window during which weed interference causes unacceptable crop yield losses. Keeping the crop weed-free during this period is essential for protecting final yields.

Solution:

Let's determine the CPWC for a direct-seeded rice (DSR) system:

(a) DSR systems lack the initial suppression advantage provided by standing water in transplanted rice, making them vulnerable to early weed competition.

(b) The critical period of weed competition in dryland DSR spans from **15 to 45 days after sowing**.

(c) This window corresponds with the crop's **peak active tillering phase**, where weed competition for light, nutrients, and water can permanently reduce tiller numbers and cause a yield collapse exceeding 50% if left unmanaged.

Final Answer: From 15 to 45 days after sowing (corresponding to peak active tillering phase).

Answer: (B)

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Answer Key

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