UPCATET Agronomy Sample Paper-2

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 late-sown wheat under North Western Plain Zone (NWPZ) conditions experiences a sudden terminal heat stress event during the anthesis stage. Which physiological trait interaction and specific developmental index drop would most accurately predict the percentage reduction in test weight (1000-grain weight)?

(A) Canopy Temperature Depression (CTD) reduction linked to an abrupt decrease in the Normalized Difference Vegetation Index (NDVI)

(B) Proline accumulation inhibition coupled with a sudden rise in the Harvest Index (HI)

(C) Increased chlorophyll fluorescence (F_v/F_m) coupled with an accelerated Leaf Area Duration (LAD)

(D) Stomatal conductance escalation coupled with high Net Assimilation Rate (NAR)

Q2. In deep-water floating rice (*Oryza sativa* L.) cultivated in the low-lying ecosystem regions of Eastern Uttar Pradesh, rapid internode elongation is critically required to escape submergence. Which endogenous hormonal cross-talk system directly drives this rapid cellular elongation response under sudden hypoxic conditions?

(A) High abscisic acid (ABA) accumulation suppressing gibberellic acid (GA_3) synthesis

(B) Ethylene entrapment inducing the expression of Sub1A-1 genes which stabilizes cytokinin levels

(C) Submergence-induced ethylene accumulation triggering the expression of SNORKEL1 and SNORKEL2 genes, which rapidly accelerates gibberellin (GA) biosynthesis

(D) High brassinosteroid concentrations inducing immediate jasmonic acid degradation

Q3. An agronomic trial on *Cajanus cajan* (Pigeonpea) targets optimization of the biological nitrogen fixation (BNF) mechanism. If the field soil displays a molybdenum (Mo) deficiency alongside a suboptimal soil pH of 5.2, which specific enzymatic block will manifest first within the active root nodules?

(A) Complete inhibition of Nitrite Reductase during the assimilation phase

(B) Structural dysfunction of the iron-molybdenum protein (FeMo-protein) complex within the nitrogenase enzyme system

(C) Rapid degradation of the leghemoglobin pigment due to lack of divalent iron ions

(D) Failure of glutamine synthetase (GS) to polymerize with glutamate synthase (GOGAT)

Q4. Consider the physiological dynamic known as "canopy reconstruction" or the ideotype approach in Sugarcane (*Saccharum officinarum*). To maximize the Radiation Use Efficiency (RUE) and optimize the Leaf Area Index (LAI) during the grand growth phase, which architectural combination is most desirable?

(A) Horizontal, wide leaves in the upper canopy layer and erect leaves in the lower layers

(B) Erect leaf angle (highly acute to the stem) in the upper canopy layer and horizontal leaf orientation in the lower canopy layers

(C) Drooping leaves throughout the canopy profile to trap diffuse light reflection

(D) Narrow, tightly whorled leaves exhibiting low specific leaf weight (SLW)

Q5. A seed production plot of Mustard (*Brassica juncea*) is severely threatened by structural mechanical lodging at the siliqua filling stage due to excessive split-nitrogen application. Which plant growth regulator system should be applied exogenous-wise to modify the lodging resistance index by optimally altering the sclerenchymatous tissue thickness in the lower stem internodes?

(A) Paclobutrazol or Chlormequat chloride (CCC) through gibberellin biosynthesis inhibition

(B) Indole-3-butyric acid (IBA) to induce sudden lateral shoot proliferation

(C) Gibberellic acid (GA_3) to prolong the vascular cambium differentiation zone

(D) Kinetin solution spray to reduce the overall lignin-to-cellulose ratio

Q6. During the physiological maturation phase of Chickpea (*Cicer arietinum* L.), the phenomenon of "malic acid exudation" from glandular hairs plays a multi-functional defense role. If a dynamic ecosystem shift reduces night temperatures below 8°C, how does the composition and concentration profile of this exudate change, and what is its agronomic implication?

(A) Exudation of malate increases drastically, directly increasing susceptibility to *Ascochyta* blight

(B) Exudation rates of malic and oxalic acids drop significantly, breaking the chemical defense shield against *Helicoverpa armigera* pod-borer larvae

(C) The exudate switches to purely citric acid, increasing phosphate solubilization rates around the rhizosphere

(D) Cellular crystallization of the acid occurs, causing acute localized stem necrosis

Q7. When evaluating the processing quality parameters of Potato (*Solanum tuberosum* L.) for industrial chip manufacturing, a low "reducing sugar" content is strictly demanded. Which precise post-harvest biochemical storage environment prevents cold-induced sweetening (CIS) by regulating vacuolar invertase activity?

(A) Storage at 2°C to 4°C under high carbon dioxide concentration

(B) Storage at 8°C to 10°C combined with application of CIPC (Isopropyl N-(3-chlorophenyl)carbamate) sprout inhibitor

(C) Continuous storage at 0°C under safe ethylene scrubbing conditions

(D) Rapid pre-cooling to −5°C followed by warm storage at 20°C

Q8. The physiological phenomenon of "Pop-corn" effect or empty pods (pops) in Groundnut (*Arachis yogaea*) is fundamentally linked to a critical nutrient transport limitation. Why does a localized deficiency of Calcium (Ca^{2+}) in the pegging zone (0 − 5 cm soil depth) induce this condition even if the deeper root zone has abundant calcium?

(A) Calcium is highly phloem-mobile and moves rapidly downward from leaves, bypassing developing pegs

(B) Calcium is phloem-immobile; developing pegs cannot receive adequate calcium via basipetal phloem transport and must absorb it directly from the surrounding soil matrix

(C) High potassium concentration in the lower roots completely blocks xylem vessels feeding the gynophore

(D) Pegs lack any functional xylem connections, making them rely entirely on active mycorrhizal transport

Q9. In Maize (*Zea mays* L.), the synchrony between the anthesis date and the silking date is mathematically quantified as the Anthesis-Silking Interval (ASI). Under extreme moisture stress conditions during reproductive initiation, what physiological shift occurs to ASI, and what is its structural consequence on grain yield?

(A) ASI narrows to zero days, causing excessive self-pollination and severe inbreeding depression

(B) ASI widens significantly due to delayed silk elongation caused by low turgor pressure, leading to poor fertilization and high kernel abortion

(C) Tassel development halts completely while silk development accelerates, leading to absolute protogyny

(D) The interval turns negative, increasing the barrenness index by shifting the plant to a purely vegetative mode

Q10. A specialized malting barley (*Hordeum vulgare*) crop requires strict management of its grain protein matrix. To achieve the premium malting grade criteria (ideal protein range of 9.5% to 11.5%), which late-stage nitrogen fertilization strategy must be enforced?

(A) High foliar application of urea at the mid-milking stage to maximize endosperm protein density

(B) Complete omission of basal nitrogen, compensated entirely by heavy top-dressing during flag leaf emergence

(C) Split nitrogen applications restricted strictly to the pre-flowering stages, avoiding late-season top-dressings that excessively boost grain protein content at the cost of starch extract

(D) Continuous ammonium nitrate fertigation up to 1 week prior to mechanical harvest

Q11. The Southwest semi-arid zone of Uttar Pradesh features prominent patches of salt-affected soils locally classified under the Usar soil complex. When reclaiming a highly sodic soil characterized by an Exchangeable Sodium Percentage (ESP) > 25 and a pH of 9.8, which chemical equation correctly identifies the role of Gypsum ($CaSO_4 \cdot 2H_2O$) application followed by adequate flushing?

(A) $2\text{Na-Clay} + CaSO_4 \rightleftharpoons \text{Ca-Clay} + Na_2SO_4 \downarrow$ (leached)

(B) $\text{Ca-Clay} + Na_2CO_3 \rightleftharpoons \text{Na-Clay} + CaCO_3 \downarrow$

(C) $\text{Na-Clay} + H_2SO_4 \rightleftharpoons \text{H-Clay} + Na_2SO_4$

(D) $2\text{Na-Clay} + CaCO_3 \rightleftharpoons \text{Ca-Clay} + Na_2CO_3$

Q12. In the Vindhyan region and parts of Bundelkhand in Uttar Pradesh, red soils (locally known as Rakar and Parwa) co-exist with black soils (Mar and Kabar). What mineralogical feature and associated structural limitation primarily explain the high susceptibility of 'Rakar' soils to accelerated water erosion under heavy monsoon downpours?

(A) Dominance of 2:1 expanding smectite clays causing extreme swelling and liquefaction

(B) Domination of kaolinite and low organic matter content, leading to poor aggregate stability, rapid surface crusting, and low infiltration capacity

(C) High abundance of illite minerals creating a highly stable structural framework that promotes deep rill formation

(D) High organic carbon fractions causing hydrophobic surface sealing behavior

Q13. A conservation agriculture system involves continuous zero-tillage management across a Typic Natrustalf soil profile. Over a five-year continuous cycle, what vertical stratification patterns of soil organic carbon (SOC) and dry bulk density (ρ_b) will typically stabilize in the upper $0-5$ cm zone compared to the deeper $15-30$ cm plow-sole layer?

(A) Uniform distribution of SOC across both layers; bulk density decreases significantly in the deeper layer

(B) High stratification ratio of SOC (heavily concentrated in the $0-5$ cm layer) along with a lower bulk density at the immediate surface, while the $15-30$ cm layer maintains a stable, higher bulk density

(C) Complete depletion of SOC in the $0-5$ cm zone due to accelerated microbial oxidation under surface exposure

(D) Inverse stratification: SOC accumulates heavily at $15-30$ cm via root exudation dynamics alone

Q14. The quantitative calculation of soil loss via water erosion is modeled using the Revised Universal Soil Loss Equation (RUSLE): $A = R \times K \times LS \times C \times P$. If a field manager implements contour bunding coupled with strip cropping on a 6% slope in the undulating terrain of Bundelkhand, which specific parameters of the equation are being manipulated directly?

(A) Only the Soil Erodibility Factor (K) and Rainfall Erosivity Factor (R)

(B) The Topographic Factor (LS) and the Cover Management Factor (C)

(C) The Cover Management Factor (C) and the Support Practice Factor (P)

(D) Only the Rainfall Erosivity Factor (R)

Q15. During a deep primary tillage operation using a moldboard plow in a heavy clayey "Kabar" soil of Uttar Pradesh, the soil mechanics switch along a moisture continuum. To prevent both "puddling/smearing" (at high moisture) and "clod shattering/high draft requirement" (at low moisture), the operation must be done at which exact physical state?

(A) At the Liquid Limit (LL) moisture threshold

(B) At the Plastic Limit (PL) transition zone, specifically within the optimum "friable" range of the soil moisture consistency curve

(C) Well below the Shrinkage Limit (SL) under absolute bone-dry conditions

(D) At maximum saturation capacity under hydrostatic equilibrium

Q16. Wind erosion in the hyper-arid microclimates of Western Uttar Pradesh (e.g., Agra and Mathura districts) operates through three distinct physical transportation modes: Saltation, Suspension, and Surface Creep. Which mathematical distribution correctly aligns the particle diameter sizes with these modes?

(A) Suspension: > 1.0 mm; Saltation: $0.5 - 1.0$ mm; Surface Creep: < 0.1 mm

(B) Suspension: < 0.1 mm; Saltation: $0.1 - 0.5$ mm; Surface Creep: $0.5 - 1.0$ mm

(C) Suspension: $0.1 - 0.5$ mm; Saltation: > 1.0 mm; Surface Creep: $0.05 - 0.1$ mm

(D) All three modes operate uniformly within a single narrow range of $2.0 - 5.0$ mm

Q17. An automated micro-irrigation layout evaluates the Crop Water Requirement (ET_c) of a high-density banana orchard. The reference crop evapotranspiration (ET_0) is computed as 6.0 mm/day using the Penman-Monteith equation, the crop coefficient (K_c) is 1.15, and the water application efficiency (η_a) of the drip system is 90%. Calculate the gross irrigation water requirement (GIR) per plant per day if each plant occupies an allocated area of 4.0 m^2.

(A) 24.60 liters/plant/day

(B) 30.66 liters/plant/day

(C) 18.44 liters/plant/day

(D) 42.12 liters/plant/day

Q18. The physiological calculation of "Critical Stages for Irrigation" in wheat is conventionally mapped to crown root initiation (CRI). Under a severe water scarcity scenario where only two irrigations are physically available for a wheat crop in light alluvial soils, what are the most agronomically sound stages to apply water to minimize yield loss?

(A) Crown Root Initiation (CRI) and Tillering stages

(B) Crown Root Initiation (CRI) and Jointing stages

(C) Crown Root Initiation (CRI) and Flowering/Booting stages

(D) Flowering and Milking stages exclusively

Q19. When designing a subsurface drainage system to reclaim a waterlogged, saline agricultural valley in the canal-command area of Sharda Sahayak Pariyojana, the steady-state spacing of tile drains (S) is calculated using Hooghoudt's Equation:

$$S^2 = \frac{8K_1dD + 4K_2D^2}{q}$$

What does the operational parameter q represent in this mathematical configuration?

(A) Total hydrostatic pressure head above the drain line

(B) Design drainage discharge rate per unit surface area (drainage coefficient)

(C) Hydraulic conductivity of the soil layers below the water table

(D) Equivalent thickness of the impermeable bottom stratum

Q20. Surge irrigation is a modification of furrow irrigation used to improve water distribution uniformity along long furrow runs. What physical mechanism operates within the soil profile during the "off" period of the intermittent water pulse cycle to drastically reduce the infiltration rate of the advanced front?

(A) Immediate structural collapse of the surface macropores coupled with surface sealing and surface tension consolidation during water recession

(B) Rapid swelling of montmorillonitic clay structures that closes all subterranean cracks within seconds

(C) Formation of a permanent chemical hardpan due to instantaneous salt precipitation

(D) Trapping of large air bubbles that completely blocks vertical saturated flow permanently

Q21. A specialized tension table and pressure plate apparatus are utilized to measure the soil moisture characteristic curve. At the "Permanent Wilting Point" (PWP), what is the typical thermodynamic matric potential (Ψ_m) value expressed in bars or mega-pascals (MPa), and which specific forces retain this water within the soil matrix?

(A) -0.33 bars (-0.033 MPa); retained by gravitational downward forces

(B) -15 bars (-1.5 MPa); retained largely as a thin film by strong adsorption and high capillary forces in micro-pores

(C) -31 bars (-3.1 MPa); retained as pure hygroscopic chemical bonds

(D) 0 bars (0 MPa); representing free energy at absolute saturation

Q22. The problematic weed *Phalaris minor* (Little seed canary grass) has developed widespread cross-resistance to the herbicide Isoproturon in the rice-wheat cropping systems of the Indo-Gangetic Plains. What biochemical mechanism explains this resistance mutation, and which alternative herbicide with a different Mode of Action (MoA) should be integrated?

(A) Target-site mutation in the EPSPS enzyme pathway; managed by Glyphosate application

(B) Enhanced metabolic degradation mediated by Cytochrome P450 monooxygenases; managed by Sulfosulfuron or Clodinafop-propargyl (ACCase inhibitors)

(C) Complete inhibition of cell wall cellulose synthesis; managed by 2,4-D sodium salt

(D) Blockage of phloem translocation systems; managed by Atrazine spray

Q23. In dryland farming systems, antitranspirants are classified into four structural groups based on operational mechanics: Stomatal closing type, Film-forming type, Reflectance type, and Growth retardants. Which of the following sets contains exclusively "Reflectance type" compounds that lower leaf temperature and reduce transpiration without disrupting carbon dioxide assimilation?

(A) Phenylmercuric Acetate (PMA) and Atrazine at low concentrations

(B) Kaolin ($5-6\%$ spray), Celite, and Calcium Carbonate suspensions

(C) Hexadecanol, Cetyl alcohol, and Silicone emulsions

(D) Cycocel (CCC) and Abscisic Acid (ABA)

Q24. A multi-species parasitic weed infestation is observed in an agronomic survey across different agro-climatic zones of Uttar Pradesh. Match the parasitic weeds—*Striga*, *Orobanche*, *Cuscuta*, and *Loranthus*—with their specific classification based on structural attachment to host systems:

(A) *Cuscuta* = Total Root Parasite; *Orobanche* = Total Stem Parasite; *Striga* = Partial Stem Parasite; *Loranthus* = Partial Root Parasite

(B) *Cuscuta* = Total Stem Parasite; *Orobanche* = Total Root Parasite; *Striga* = Partial Root Parasite; *Loranthus* = Partial Stem Parasite

(C) *Cuscuta* = Partial Stem Parasite; *Orobanche* = Partial Root Parasite; *Striga* = Total Root Parasite; *Loranthus* = Total Stem Parasite

(D) All four are uniformly classified as facultative endo-parasitic saprophytes

Q25. Under dryland conditions, the parameter Moisture Utilization Efficiency (MUE) or Water Use Efficiency (WUE) is a critical metric. For a dryland Pearl Millet (*Pennisetum glaucum*) crop, if the total Evapotranspiration (ET) is 250 mm, Deep Percolation loss is 30 mm, Runoff is zero, and the Economic Yield is 2200 kg/ha, calculate the Crop Water Use Efficiency (WUE_{crop}).

(A) 8.80 kg/ha-mm

(B) 7.85 kg/ha-mm

(C) 73.33 kg/ha-mm

(D) 9.56 kg/ha-mm

Detailed Solutions

Q1.

Solution

Concept: Terminal heat stress during anthesis severely accelerates senescence, limits the grain filling duration, and reduces final grain weight in wheat crops. To accurately monitor and predict the impact of this stress, physiological monitoring traits must capture both the canopy transpiration status and the structural integrity of the green leaf area.

Solution:

Let's evaluate the primary traits used to monitor heat stress impacts:

(a) **Canopy Temperature Depression (CTD)** is calculated as the difference between the ambient air temperature (T_a) and the canopy temperature (T_c): CTD $= T_a - T_c$. A positive CTD indicates a cooler canopy, which is driven by efficient stomatal conductance and high transpiration rates. Under heat stress, stomata close, transpiration drops, and CTD falls toward zero or becomes negative.

(b) The **Normalized Difference Vegetation Index (NDVI)** measures green biomass and stays stable during active vegetative growth but drops sharply as chlorophyll degrades during heat-induced forced senescence.

(c) A drop in both parameters tracks the combined reduction in photosynthetic stay-green duration and transpiration capacity, providing a reliable physiological predictor for loss in test weight.

Final Answer: $\boxed{\text{Canopy Temperature Depression (CTD) reduction linked to an abrupt decrease in the Normalized Difference Vegetation Index (NDVI)}}$

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

Go Back to Question 1

Q2.

Solution

Concept: Deep-water floating rice varieties adapt to rising floodwaters through a rapid internode elongation mechanism triggered by an internal hormonal signaling pathway.

Solution:

Let's evaluate the hormonal cascade under submergence conditions:

(a) When plants are submerged, gas diffusion slows down, trapping the gas molecule **ethylene** within the air spaces of the internodal tissues.

(b) This accumulation of ethylene activates the transcription factors **SNORKEL1 (SK1)** and **SNORKEL2 (SK2)**, which are specific to deep-water rice varieties.

(c) The expression of these SNORKEL genes triggers a rapid increase in the biosynthesis of **gibberellic acid** (GA), which accelerates cell division and elongation in the internodal region, allowing the plant to keep its canopy above the rising water line.

Final Answer: Submergence-induced ethylene accumulation triggering the expression of SNORKEL1 and SNORKEL2 genes, which rapidly accelerates gibberellin (GA) biosynthesis

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept: Biological nitrogen fixation (BNF) relies on the functioning of the nitrogenase enzyme complex within root nodules. This enzyme complex is sensitive to both micronutrient deficiencies and soil acidity.

Solution:

Let's evaluate how molybdenum deficiency and low pH affect the nodule enzyme systems:

(a) The nitrogenase enzyme is a two-component complex made of an **iron protein (Fe-protein)** and an **iron-molybdenum protein (FeMo-protein)**. The FeMo-protein houses the catalytic iron-molybdenum cofactor (FeMoco) where dinitrogen reduction takes place.

(b) A deficiency in molybdenum (Mo) prevents the synthesis of this essential cofactor, causing a direct structural and functional block in the FeMo-protein.

(c) This problem is worsened by a low soil pH (5.2), which reduces the availability of molybdenum in the soil and impairs root infection, leading to a failure in nitrogen fixation.

Final Answer: Structural dysfunction of the iron-molybdenum protein (FeMo-protein) complex within the nitrogenase enzyme system

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept: Canopy architecture design (or the ideotype approach) in high-biomass crops like sugarcane focuses on improving light distribution profiles to maximize the Radiation Use Efficiency (RUE).

Solution:

Let's analyze the optimal leaf angle arrangement down a crop canopy profile:

(a) An ideal crop canopy uses an **erect leaf angle** in the upper layers. This orientation allows bright, direct midday sunlight to pass down into the canopy rather than saturating the top leaves, which reduces heat and photo-inhibition stresses at the surface.

(b) In the lower canopy layers, leaves are oriented **horizontally**. This horizontal arrangement acts as a catchment web to capture the lower-intensity diffuse light that filters through the upper layers.

(c) This structural combination ensures a balanced light profile across the leaf area index (LAI), keeping lower leaves active and maximizing RUE during the high-demand grand growth phase.

Final Answer: $\boxed{\text{Erect leaf angle (highly acute to the stem) in the upper canopy layer and horizontal leaf orientation in the lower canopy layers}}$

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Mechanical lodging in oilseed brassicas is often aggravated by excessive vegetative growth and high nitrogen applications, which reduce stem wall thickness. Plant growth regulators can alter these stem characteristics to improve lodging resistance.

Solution:

Let's evaluate the modes of action of the growth regulators listed:

(a) Anti-gibberellins like **Paclobutrazol** and **Chlormequat chloride (CCC)** block specific steps in the gibberellin biosynthesis pathway (such as ent-kaurene oxidation).

(b) Reducing active internal gibberellin levels shortens the elongation of lower stem internodes.

(c) This inhibition also shifts resource allocation to prompt radial growth, thickening the structural sclerenchyma cell layers and increasing cell wall lignification to improve the stem's overall lodging resistance.

Final Answer: $\boxed{\text{Paclobutrazol or Chlormequat chloride (CCC) through gibberellin biosynthesis inhibition}}$

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

Go Back to Question 5

Q6.

Solution

Concept: Glandular trichomes on chickpea leaves and pods secrete organic acids, primarily malic and oxalic acids. This chemical exudate acts as a natural defense barrier against insect pests like the pod-borer (*Helicoverpa armigera*).

Solution:

Let's evaluate the impact of low temperature on this defense trait:

(a) The active exudation of organic acids from these glandular cells is a metabolic, energy-dependent transport process.

(b) When night temperatures drop below 8°C, the plant's metabolic activity slows down, reducing acid synthesis and secretion.

(c) This drop in malic and oxalic acid concentrations thins out the acidic surface layer, removing the chemical feeding deterrent and making the pods more vulnerable to attack by pod-borer larvae.

Final Answer: $\boxed{\text{Exudation rates of malic and oxalic acids drop significantly, breaking the chemical defense shield against Helicoverpa armigera pod-borer larvae}}$

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

Go Back to Question 6

Q7.

Solution

Concept: When potato tubers are stored at low temperatures, they are prone to Cold-Induced Sweetening (CIS). This process occurs when starch is converted into reducing sugars (glucose and fructose) via the activation of vacuolar invertase (VInv). During high-temperature frying, these reducing sugars react with free amino acids (Maillard reaction) to produce bitter, dark-colored chips.

Solution:

Let's analyze the standard industrial storage temperature configurations:

(a) Storing tubers at low temperatures (2°C to 4°C) triggers CIS and increases reducing sugar levels, making them less suitable for processing.

(b) To minimize sugar accumulation, processing potatoes are stored at a higher temperature range of 8°**C to** 10°**C**, which keeps vacuolar invertase activity low.

(c) Because these warmer temperatures encourage sprouting, the treatment is combined with an application of a sprout inhibitor like **CIPC** (Chlorpropham) to prevent weight loss and preserve processing quality.

Final Answer: $\boxed{\text{Storage at 8°C to 10°C combined with application of CIPC (Isopropyl N-(3-chlorophenyl)carbamate) sprout inhibitor.}}$

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

Go Back to Question 7

Q8.

Solution

Concept: Calcium (Ca^{2+}) is essential for structural cell wall stability and pod development in groundnuts. A localized lack of calcium during the pegging stage leads to aborted embryos and empty pods, commonly known as the "pop-corn" effect or "pops."

Solution:

Let's examine the transport mechanics of calcium within the plant:

(a) Calcium moves through the plant almost exclusively via the xylem, driven by transpiration pull. It has very low mobility within the phloem tissue (**phloem-immobile**).

(b) Because calcium cannot move from older leaves down to the developing pods via the phloem, the subterranean pegs cannot rely on the main root system for their calcium supply.

(c) Instead, the growing pegs and pods must absorb calcium directly from their immediate surrounding soil layer (0 – 5 cm pegging zone). If this shallow layer lacks soluble Ca^{2+}, the pod will fail to fill properly, regardless of how much calcium is available in the deeper root zone.

Final Answer: $\boxed{\text{Calcium is phloem-immobile; developing pegs cannot receive adequate calcium via basipetal phloem transport and must absorb it directly from the surrounding soil matrix}}$

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

Go Back to Question 8

Q9.

Solution

Concept: The Anthesis-Silking Interval (ASI) measures the time gap between the start of pollen shedding (anthesis) and the emergence of receptive silks (silking) in maize. It is a key indicator of reproductive success under drought stress.

Solution:

Let's analyze the effects of moisture stress on maize reproductive dynamics:

(a) Tassel development and pollen shedding are relatively resilient to mild-to-moderate water stress. However, silk elongation is driven by cell expansion, which depends heavily on high **turgor pressure**.

(b) Under severe moisture stress, a drop in leaf and stem water potential delays silk elongation, causing a lag in silk emergence.

(c) This delays silking while anthesis continues, widening the ASI significantly. By the time the silks emerge, pollen availability may be low, leading to poor fertilization, grain missing on the cob, and high kernel abortion rates.

Final Answer: ASI widens significantly due to delayed silk elongation caused by low turgor pressure, leading to poor fertilization and high kernel abortion

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Malting barley requires precise nitrogen management to maintain grain protein within the target range (9.5% to 11.5%). Excessively high protein levels lower the percentage of fermentable carbohydrates (starch extract) and cause cloudiness in the final product.

Solution:

Let's evaluate the timing of nitrogen applications on grain quality:

(a) Applying nitrogen late in the season, such as during the milking or grain-filling stages, boosts the accumulation of storage proteins (hordeins) in the endosperm without increasing total grain yield.

(b) To prevent this excess protein accumulation, nitrogen applications are restricted to **early vegetative and pre-flowering stages**.

(c) This split-application strategy ensures adequate early vegetative growth while allowing carbohydrate synthesis to dominate during grain filling, keeping the final grain protein within premium malting limits.

Final Answer: $\boxed{\text{Split nitrogen applications restricted strictly to the pre-flowering stages, avoiding late-season top-dressings that excessively boost grain protein content at the cost of starch extract}}$

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

Go Back to Question 10

Q11.

Solution

Concept: Sodic soils contain high concentrations of exchangeable sodium (Na^+) on clay surfaces, which destabilizes soil aggregates and increases pH. Reclaiming these soils requires replacing exchangeable sodium with calcium (Ca^{2+}) ions, followed by leaching to remove the displaced sodium.

Solution:

Let's look at the chemical reaction when gypsum ($CaSO_4 \cdot 2H_2O$) is applied:

(a) When gypsum dissolves in the soil solution, it releases soluble calcium ions (Ca^{2+}).

(b) Because calcium has a higher valence and stronger affinity for exchange sites than sodium, it replaces the exchangeable Na^+ on the clay mineral complex.

(c) The chemical exchange reaction is:

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

The resulting sodium sulfate (Na_2SO_4) is a highly soluble neutral salt that can be safely flushed and leached down below the root zone, reducing the soil's Exchangeable Sodium Percentage (ESP).

Final Answer: $\boxed{2\text{Na-Clay} + CaSO_4 \rightleftharpoons \text{Ca-Clay} + Na_2SO_4 \downarrow \text{(leached)}}$

Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept: The red 'Rakar' soils found in the undulating landscapes of the Vindhyan and Bundelkhand regions are highly susceptible to water erosion during heavy monsoon rains due to their inherent mineral and structural properties.

Solution:

Let's evaluate the structural features of these red soils:

(a) Rakar soils are dominated by **kaolinite**, a 1:1 non-expanding silicate clay mineral with low cation exchange capacity (CEC) and minimal binding affinity.

(b) These soils generally have a **low organic matter content**, which leads to weak aggregate stability.

(c) When exposed to heavy rainfall, the fragile soil aggregates quickly break down. The detached fine particles clog surface pores, causing rapid crust formation and reducing the soil's infiltration capacity. This results in high surface runoff and accelerated water erosion.

Final Answer: Domination of kaolinite and low organic matter content, leading to poor aggregate stability, rapid surface crusting, and low infiltration capacity

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: Continuous zero-tillage management modifies soil physical and chemical profiles by eliminating structural inversion, which leads to the vertical stratification of soil properties over time.

Solution:

Let's evaluate the stratification patterns that emerge under zero-tillage:

(a) Leaving crop residues on the surface leads to an accumulation of **soil organic carbon (SOC)** in the shallow $0-5$ cm layer, creating a distinct vertical stratification gradient.

(b) The increased organic matter concentration, combined with biological activity near the surface, helps lower the dry bulk density (ρ_b) of this immediate top layer.

(c) In contrast, the deeper $15-30$ cm layer is not physically disturbed by tillage implements, so it maintains a stable, higher bulk density over time.

Final Answer: High stratification ratio of SOC (heavily concentrated in the 0–5 cm layer) along with a lower bulk density at the immediate surface, while the 15–30 cm layer maintains a stable, higher bulk density.

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept: The Revised Universal Soil Loss Equation (RUSLE) calculates average annual soil loss (A) based on five distinct factors:

$$A = R \times K \times LS \times C \times P$$

Solution:
Let's analyze how field management practices map to the specific components of the equation:

(a) **Strip cropping** involves planting alternating strips of erosion-permitting and erosion-resisting crops. This practice modifies the vegetative ground cover profile over time, which directly adjusts the **Cover Management Factor (C)**.

(b) **Contour bunding** is a structural support practice designed to slow down runoff water on sloped fields. This engineering intervention maps directly to the **Support Practice Factor (P)**.

(c) The rainfall erosivity (R), soil erodibility (K), and slope steepness (LS) are physical site properties that are not directly altered by these specific field management practices.

Final Answer: $\boxed{\text{The Cover Management Factor (C) and the Support Practice Factor (P)}}$

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

Go Back to Question 14

Q15.

Solution

Concept: Soil consistency describes how a soil deforms or fractures under mechanical force at different moisture content levels along the Atterberg continuum.

Solution:

Let's evaluate the physical states of a heavy clay soil like 'Kabar':

(a) Working the soil near its **Liquid Limit (LL)** causes severe compaction, smearing, and structural damage (puddling) because the soil behaves like a viscous fluid.

(b) Tilling the soil below its **Shrinkage Limit (SL)** requires high draft force and breaks the soil into large, hard clods instead of a clean tilth.

(c) The ideal moisture range for primary tillage is near the **Plastic Limit (PL) transition zone**, specifically within the **friable** range. In this state, the soil maintains enough tensile cohesion to prevent smearing, yet fractures easily into a crumbly structure under the mechanical action of a moldboard plow.

Final Answer: $\boxed{\text{At the Plastic Limit (PL) transition zone, specifically within the optimum "friable" range of the soil moisture consistency curve}}$

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: Wind erosion transports soil particles through three physical modes depending on particle diameter sizes: suspension, saltation, and surface creep.

Solution:

Let's evaluate the particle size classifications for each transportation mode:

(a) **Suspension:** Very fine sand and dust particles with diameters **< 0.1 mm** are lifted high into the air column by wind turbulence and can remain suspended over long distances.

(b) **Saltation:** Medium-sized soil particles ranging from **0.1 mm to 0.5 mm** move by bouncing across the soil surface, gaining and transferring kinetic energy as they land. This is often the primary driver of wind erosion.

(c) **Surface Creep:** Larger sand grains with diameters between **0.5 mm and 1.0 mm** are too heavy to be lifted or bounced. Instead, they roll or slide along the surface after being struck by saltating particles.

Final Answer: $\boxed{\text{Suspension: } < 0.1 \text{ mm; Saltation: } 0.1 - 0.5 \text{ mm; Surface Creep: } 0.5 - 1.0 \text{ mm}}$

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept: The gross irrigation water requirement (GIR) accounts for both the biological crop water demand (ET_c) and the application efficiency (η_a) of the irrigation system.

Solution:

Let's calculate the values step-by-step:

(a) First, determine the **Crop Evapotranspiration (ET_c)** depth:

$$\mathrm{ET}_c = \mathrm{ET}_0 \times K_c = 6.0 \text{ mm/day} \times 1.15 = 6.90 \text{ mm/day}$$

(b) Next, calculate the **Gross Water Depth Requirement** by factoring in the system efficiency ($\eta_a = 90\% = 0.90$):

$$\text{Gross Depth} = \frac{\mathrm{ET}_c}{\eta_a} = \frac{6.90 \text{ mm/day}}{0.90} \approx 7.6667 \text{ mm/day}$$

(c) Convert this daily irrigation depth into a volume for an individual plant occupying an area of 4.0 m^2 (recall that 1 mm = 1 liter/m^2):

$$\mathrm{GIR} = 7.6667 \text{ mm/day} \times 4.0 \text{ m}^2 = 30.6667 \text{ liters/plant/day}$$

Final Answer: $\boxed{30.66 \text{ liters/plant/day}}$

Answer: (B)

Go Back to Question 17

Q18.

Solution

Concept: When managing limited irrigation options under water scarcity, applications are timed to protect the crop's most sensitive critical growth stages.

Solution:

Let's analyze the critical stages for wheat irrigation:

(a) The single most critical stage for wheat is **Crown Root Initiation (CRI)**, which occurs around 21 days after sowing. Missing irrigation at this stage restricts crown root development and tillering, causing significant yield losses.

(b) If a second irrigation is available, it is best applied at the **Flowering/Booting stage**. This stage is highly sensitive to moisture stress because water deficits can cause pollen sterility and reduce the final floret number per spikelet.

(c) Prioritizing the CRI and Flowering stages helps sustain both early tiller development and late seed-set metrics, optimizing water productivity under scarcity.

Final Answer: $\boxed{\text{Crown Root Initiation (CRI) and Flowering/Booting stages}}$

Answer: (C)

Go Back to Question 18

Q19.

Solution

Concept: Hooghoudt's equation is used to calculate the steady-state spacing (S) of parallel subsurface agricultural drains. The equation balances water input with drain discharge capacity:

$$S^2 = \frac{8K_1 dD + 4K_2 D^2}{q}$$

Solution:
Let's define the parameters used in this equation:

(a) K_1 and K_2 represent the hydraulic conductivities of the soil layers above and below the drain lines, respectively.

(b) D is the water table height midway between the drains relative to the drain level, and d is Hooghoudt's equivalent depth parameter.

(c) The variable **q** represents the **design drainage discharge rate per unit surface area** (also called the drainage coefficient). It measures the volume of water the drainage system must remove per unit area per day (m/day or mm/day) to maintain the target water table level midway between the drains.

Final Answer: $\boxed{\text{Design drainage discharge rate per unit surface area (drainage coefficient)}}$

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

Go Back to Question 19

Q20.

Solution

Concept: Surge irrigation applies water to furrows intermittently in a series of "on" and "off" cycles. This cyclical application reduces the soil's infiltration capacity, allowing the water front to advance more quickly along the furrow.

Solution:

Let's look at what happens during the "off" period of the cycle:

(a) When the water flow stops, water recedes from the surface, causing a negative pressure gradient (tension) in the soil pores near the surface.

(b) This tension causes the soil surface layer to consolidate. Fine suspended soil particles settle into and clog the surface macropores, creating a thin **surface seal**.

(c) When the next surge of water arrives, this consolidated surface layer acts as a barrier that significantly reduces the infiltration rate, allowing water to advance more efficiently down the remainder of the furrow.

Final Answer: Immediate structural collapse of the surface macropores coupled with surface sealing and surface tension consolidation during water recession

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept: The Permanent Wilting Point (PWP) is the lower limit of plant-available soil water. At this point, the soil retains water with a force that exceeds the maximum suction pressure roots can exert.

Solution:

Let's evaluate the thermodynamic metrics and retention forces at PWP:

(a) The standard matric potential (Ψ_m) at the permanent wilting point is **-15 bars**, which is equivalent to **-1.5 MPa**.

(b) At this potential, macro- and meso-pores have drained completely.

(c) The remaining water is held inside **micro-pores** and as thin films around clay particles. This water is retained by strong physical adsorption and capillary forces, making it largely unavailable for uptake by agricultural crops.

Final Answer: -15 bars (-1.5 MPa); retained largely as a thin film by strong adsorption and high capillary forces in micro-pores.

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: Herbicide resistance in weeds like *Phalaris minor* often develops due to non-target-site mutations that accelerate the breakdown of the herbicide before it reaches its target site.

Solution:

Let's look at the resistance mechanism and alternative control options:

(a) Isoproturon resistance in *Phalaris minor* is primarily driven by enhanced metabolic degradation mediated by **Cytochrome P450 monooxygenases**, which detoxify the herbicide molecule.

(b) To control these resistant biotypes, managers use alternative herbicides with a different Mode of Action (MoA). Sulfosulfuron (an ALS inhibitor) or **Clodinafop-propargyl** (an ACCase inhibitor) can be integrated into the rotation to control the weed population and slow down the development of further resistance.

Final Answer: Enhanced metabolic degradation mediated by Cytochrome P450 monooxygenases; managed by Sulfosulfuron or Clodinafop-propargyl (ACCase inhibitors)

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: Reflectance-type antitranspirants are materials sprayed onto leaf surfaces to increase their albedo (reflectivity), which helps reduce the amount of solar radiation absorbed by the canopy.

Solution:

Let's look at the classifications of the different compounds:

(a) Compounds like **Kaolin**, **Celite**, and **Calcium Carbonate suspensions** form a thin, white coating on the leaves when sprayed at low concentrations ($5 - 6\%$).

(b) This coating reflects a portion of the incoming light, lowering leaf temperature and reducing the vapor pressure deficit (VPD) across the stomata, which decreases the transpiration rate.

(c) Because these materials do not completely block the stomatal pore, carbon dioxide (CO_2) assimilation can continue, helping maintain photosynthesis under dryland conditions.

Final Answer: Kaolin ($5 - 6\%$ spray), Celite, and Calcium Carbonate suspensions

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept: Parasitic weeds are classified based on whether they attach to the root or stem of their host, and whether they lack chlorophyll entirely (total parasite) or possess some photosynthetic capability (partial parasite).

Solution:

Let's look at the standard structural classification for each genus:

(a) ***Cuscuta*** (Dodder): Lacks functional roots and chlorophyll, attaching directly to host stems. It is a **Total Stem Parasite**.

(b) ***Orobanche*** (Broomrape): Lacks chlorophyll and attaches to the root system of hosts like solanaceous crops. It is a **Total Root Parasite**.

(c) ***Striga*** (Witchweed): Possesses some chlorophyll but relies on host roots for water and nutrients. It is a **Partial Root Parasite**.

(d) ***Loranthus*** (Mistletoe): Grows on the branches of woody trees and performs photosynthesis, but draws water and minerals from the host stem. It is a **Partial Stem Parasite**.

Final Answer: $\boxed{\text{Cuscuta = Total Stem Parasite; Orobanche = Total Root Parasite; Striga = Partial Root Parasite; Loranthus = Partial Stem Parasite}}$

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

Go Back to Question 24

Q25.

Solution

Concept: Crop Water Use Efficiency (WUE_{crop}) is calculated as the ratio of economic crop yield (Y) to the total water lost via evapotranspiration (ET) during the growing season:

$$\text{WUE}_{\text{crop}} = \frac{Y}{\text{ET}}$$

Solution:
Let's calculate the values step-by-step:

(a) Identify the relevant parameters provided:

- Economic Yield (Y) = 2200 kg/ha
- Evapotranspiration (ET) = 250 mm
- *Note:* Deep percolation (30 mm) and runoff are field water loss terms used to calculate field water use efficiency ($\text{WUE}_{\text{field}}$), but are excluded when calculating the specific biological crop water use efficiency (WUE_{crop}).

(b) Substitute the values into the equation:

$$\text{WUE}_{\text{crop}} = \frac{2200 \text{ kg/ha}}{250 \text{ mm}} = 8.80 \text{ kg/ha-mm}$$

Final Answer: $\boxed{8.80 \text{ kg/ha-mm}}$

Answer: (A)

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Answer Key

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