出國報告（出國類別：研習）

參加愛荷華州立大學種子檢查短期課程 -潔淨度分析研習報告

Report of Attending Iowa State University Seed Analyst Short Course – Purity Testing

服務機關：行政院農委會種苗改良繁殖場
姓名職稱：劉芳怡 助理研究員
派赴國家：美國
出國期間：民國 107 年 4 月 28 日至 5 月 6 日
報告日期：民國 107 年 6 月 6 日

公 務 出 國 報 告 摘 要

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報告名稱：**參加愛荷華州立大學種子檢查短期課程-潔淨度分析研習報告**

主辦機關：行政院農業委員會種苗改良繁殖場

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關鍵詞：種子分析師協會(Association of Official Seed Analysts, AOSA)、商業種子技術協會(Society of Commercial Seed Technologists, SCST)、種子檢查（Seed Testing）、潔淨度（Purity）

內容摘要：

種子檢查為種子生產過程中管控種子品質之重要工作，國際種子檢查協會（International Seed Testing Association, ISTA）針對國際上種子檢查實驗室進行認證，本場於 101 年起承接種子檢查室業務，為全國唯一 ISTA 認證實驗室，為維持 ISTA 認證資格，透過參與各項種子檢查技術研習以加強人員專業能力為重要訓練方式之一，本次參與愛荷華州立大學種子科學中心舉辦之「種子檢查短期課程-潔淨度分析」，以美國種子分析師協會（AOSA）規則為主，課程內容為種子檢查中潔淨度分析相關訓練，包含基礎的取樣、分樣，以及 32 種作物的潔淨度檢查要點，如：十字花科薹薑屬、禾本科、菊科、豆科等雜糧、蔬菜與飼料作物種子，以及同科作物種子與雜草種子的辨別，另還有標準風選流程、種子計數、容許度計算、披衣及造粒種子潔淨度檢查等相關課程與操作，並模擬 AOSA 潔淨度檢查人員認證考試測驗受訓學員潔淨度檢查能力。

本次研習透過與其他國家種子檢查人員交流，了解並比較不同種子檢查系統規範之種子檢查技術與差異，並針對檢查業務實際問題於相關課堂上提出與學員及講師進行討論，以學習其他國家優點，改善、精進檢查技術，達到提升我國種子檢查室專業能力之目的；政府近年推動「大糧倉計畫」期望提升國產雜糧栽培面積、提升糧食自給率、種植進口替代作物，愛荷華州位於美國中西部為重要玉米及大豆產區，種子檢查業務也多為這兩種作物，包含品種鑑定、基改檢測等，相關檢測技術及規範可作為我國未來雜糧種子品質監控把關的參考。

目次

壹、前言

種子檢查為種子生產過程中管控種子品質之重要工作，國際種子檢查協會（International Seed Testing Association, ISTA）則針對國際上種子檢查實驗室進行認證，我國政府為確保繁殖及銷售品質優良之種子、執行種子檢查工作，故設立種子檢查室執行相關業務；本場於 101 年起承接種子檢查室業務，除是 ISTA 會員實驗室外亦為全國唯一 ISTA 認證實驗室，認證項目包含：抽樣 (Sampling)、潔淨度分析 (Purity & determination of other seeds)、發芽率檢查(Germination)、種子健康檢查(Seed health) 及水分測定(Moisture content determination)，近年亦積極增加認證項目，林木種子檢查及種子活力檢測皆納入申請規劃中。

種子分析師協會(Association of Official Seed Analysts, AOSA)及商業種子技術協會(Society of Commercial Seed Technologists, SCST)為北美地區種子檢查組織，成立於 1917 年，會員實驗室主要來自美國及加拿大，相較國際種子檢查協會（ISAT），AOSA 雖為地區型種子檢查組織，但由於美國及加拿大為種子進出口重要國家，世界上許多與其有貿易往來的國家必須使用 AOSA 的檢查規則以符合客戶需求，且 AOSA 的檢查結果可達到美國聯邦及州種子法律規定的最低標示要求，因此 AOSA 與 ISTA 並列為世界兩大種子檢查協會。

我國政府近年推動「大糧倉計畫」及「新南向政策」，前者著重於調整稻米產業結構及配合活化休耕政策，預計至 2020 年增加雜糧面積 3 萬公頃，產量約 30 萬公噸，以提高國產雜糧自給率；後者則期望與南向東協、南亞及紐澳等新興經濟體國家，創造互利共贏新合作模式，建立「經濟共同體意識」，其工作計畫包含「經貿合作」、「人才交流」、「資源共享」、「區域連結」四大主軸，這兩個政府重大政策中農業都佔有舉足輕重的地位，而種子為農業的本源，無論是出口或供國內栽培使用，種子品質都必須嚴格的把關。

貳、研習目的

為維持本實驗室 ISTA 認證資格，透過參與各項種子檢查技術研習以加強人員專業能力為重要訓練方式之一，潔淨度檢查為維護種子品質的第一道關卡，透過潔淨度檢查可了解種子批中潔淨種子、其他作物種子、雜草種子及無生命雜質所佔的比率，作為種子品質評估的依據之一。本次參與愛荷華州立大學種子科學中心舉辦之「種子檢查短期課程-潔淨度分析」，目的在加強檢查人員對潔淨度檢查項目操作之熟悉度、認識不同作物種類的潔淨度檢查要點、了解並比較不同種子檢查系統規範、與國際種子檢查專業人員進行交流、將日常檢查遭遇問題與講師及其他學員討論、汲取經驗，進而精進我國種子檢查室之專業能力。

參、研習內容

一、 出國期間：中華民國 107 年 4 月 28 日至 5 月 6 日，為期 9 天。

二、 出國研習人員

姓　名	職　稱	服 務 單 位
劉芳怡	助理研究員	農業委員會種苗改良繁殖場種苗經營課

三、 行程安排

日期	內容
107.04.28 （六）	自桃園機場搭機前往美國愛荷華州得梅因機場，途中於西雅圖國際機場轉機至芝加哥奧海爾國際機場，再轉機至得梅因機場。
107.04.29 （日）	
107.04.30 （一）	1. 課程總覽及簡介 2. 種子取樣、分樣及減量介紹 3. 花序、花朵及種子構造介紹 4. 美國種子法規簡介 5. 豆類作物與雜草種子辨識特徵介紹 6. 植物分類學簡介 7. 種子計數標準流程簡介及種子計數器操作示範 8. 實作：小型豆科種子（三葉草屬、草木樨屬等）及大型豆科種子（豌豆屬、蠶豆屬、菜豆屬等）比較、白花三葉草潔淨度檢查與其他種子鑑別
107.05.01 （二）	1. 種子檢查概述-潔淨度分析及規則 2. 禾本科草類種子辨識特徵介紹及檢查應用 3. 種子標準風選流程介紹及操作 4. 單一及複合種子介紹與辨別程序 5. 實作：黑麥草及羊茅辨別、匍匐冰草及小麥草辨別、原生草種

	辨別、單一及複合種子辨別與檢查、混合草皮種子潔淨度檢查
107.05.02 （三）	1. 美國種子驗證制度簡介 2. AOSA 及 SCST 綜合測驗介紹 3. 十字花科蔓薹屬作物與雜草種子辨識特徵介紹 4. 菊科作物及雜草種子辨識特徵介紹 5. 潔淨度檢查容許度計算介紹 6. 實作：大豆種臍特徵辨別、穀類種子辨別、十字花科蔓薹屬種子辨別、麥類種子辨別、菊科種子辨別
107.05.03 （四）	1. 披衣、造粒、鑲衣種子潔淨度檢查介紹與實作 2. AOSA 潔淨度測驗模擬-筆試 3. AOSA 潔淨度測驗模擬-種子鑑別與檢查實作 4. 模擬測驗結果及問題討論 5. 參觀 ISU 種子檢查室
107.05.04 （五）	參觀 ISU-Reiman 花園及蝴蝶復育溫室
107.05.05 （六）	自愛荷華州返回桃園國際機場。
107.05.06 （日）	

四、　研習內容

本次研習課程內容主要學習各科大宗作物種子潔淨度檢查特徵要點，並比較形態、外觀相近的其他作物或雜草種子要如何鑑別，除此之外，課程也包含「花序、花朵及種子構造介紹」及「植物分類學簡介」等植物學概述，種子潔淨度檢查須具備的基本概念包含「種子取樣、分樣及減量介紹」、「種子標準風選流程介紹及操作」、「種子計數標準流程簡介及種子計數器操作示範」等，而「美國種子法規簡介」、「美國種子驗證制度簡介」使學員了解種子檢查法源及驗證制度，「種子檢查概述-潔淨度分析及規則」、「單一及複合種子介紹與辨別程序」、「潔淨度檢查容許度計算介紹」、「披衣、造粒、鑲衣種子潔淨度檢查介紹與實作」、「AOSA 及 SCST 綜合測驗介紹」、「模擬測驗」則幫助學員了解美國 AOSA 潔淨度檢查規則及認證測驗並取得資格，研習期間參觀「ISU 種子檢查室」及「ISU-Reiman 花園及蝴蝶復育溫室」了解愛荷華州立大學種子檢查運作與植物、昆蟲保育工作內容；以下摘錄部分課程重點：

(一)　「花序、花朵及種子構造介紹」及「植物分類學簡介」

「花序、花朵及種子構造介紹」由 ISU 農藝系助理教授 Dr. Susana Goggi 授課、「植物分類學簡介」由 ISU-Ada Hayden 植物標本館館長 Deb Lewis 授課。種子潔淨度檢查主要是以種子外觀進行種子批的物理純度與遺傳純度判定，會將檢查結果分為潔淨種子、其他作物種子、雜草種子與無生命雜質，並且鑑別出雜草種子及其他作物種子的屬名，種子構造特徵為主要判定依據，因此在檢查前必須了解種子構造、名稱及其對應之花朵部位；各科別作物種子辨別特徵不同，通常同科或同屬種子構造上會有相似的地方，面對未知種子時可依靠這些特徵去推論所屬科別，植物分類學提供了植物間親緣關係與分類依據、命名方式、對外觀的描述、植物識別，潔淨度檢查時為查找正確名稱須使用國際通用的學名，學名係遵照國際植物命名法規訂定，由拉丁文的屬名加種名組合而來，種子構造與植物分類學可視為種子潔淨度檢查的基礎。

(二)　美國種子法規與驗證制度

本課程由種子實驗室主管 Michael Stahr 講授。美國種子法規之制定最初是 1821 年康乃狄克州通過州法禁止含有雜草加拿大薊的草類種子販售，爾後各州陸續訂定相關法律來管控雜草蔓延，1939 年美國通過聯邦種子法（Federal Seed Act, FSA）管理州際及國際種子買賣，而各州內的種子買賣行為則由各州以州法規定並受美國農業部（United States Department of Agriculture, USDA）監督，在美國 AOSA 種子檢查規則直接與聯邦種子法令及其規定連結，經 AOSA 種子檢查之種子批即符合 FSA 對商品種子檢查的最低要求，且可依檢查結果給與種子批驗證標籤，因此美國種子檢查實驗室必須為 AOSA 或 SCST 之會員，有部分亦為 ISTA 會員，且為官方種子檢查室或由具有經註冊的種子技術專家（registered seed technologist, RST）之私人或公司實驗室，標籤內容至少須包含作物種類、品種、種子批號、來源、雜草種子占比、有害雜草種子種類、其他種子占比、無生命雜質含量、發芽率、硬粒種子比率、發芽檢測日期、種苗商資訊及有效日期。

種子驗證是由第三方單位對種子品種、純度、品質、種類等資訊進行檢查及確認，於種子品種開發、量產、包裝、運輸過程中維持種子身分及純度，避免品種混雜、純度不佳、同一種子多個不同名稱等的情況發生；美國官方種子認證機構協會（Association of Official Seed Certifying Agencies ,AOSCA）將種子區分為育種者（Breeder）、基礎（Foundation）、註冊（Registered）及驗證（Certified）種子 4 種，由認證機構依據國家標準進行種子生產田間檢查、種子室內檢查及給予合格產品驗證標示，如此種子商品才可於市場上販售。

(三)　「種子取樣、分樣及減量」、「種子標準風選流程」及「種子計數標準流程」

1. 種子取樣、分樣及減量：本課程由種子實驗室分析員 Jassica Wilker Blake 講授。取樣為種子檢查過程中重要的環節之一，種子批往往數量過於龐大無

法全數檢查，如何自母體中取出均質且具有代表性的樣本必須仰賴正確的取樣、分樣及減量方式及頻度來達成，ISTA 及 AOSA 有各自須依循的取樣頻度表，AOSA 原則上為 5 加上容器總量之 10%為取樣容器數量，上限為 30 個容器，而 ISTA 取樣頻度高於 AOSA，以 10 個種子容器為例，AOSA 須於 5+10*10% = 6 個容器中取出種子樣品混合，ISTA 則要從 10 個容器中取種子樣品混合，之後經分樣及減量得到潔淨度檢查樣本，而種子健康檢查及分子生物檢查等非傳統種子檢查之取樣則依照另外的規定進行。

2. 種子標準風選流程：本課程由種子實驗室分析員 Jassica Wilker Blake 講授。為減輕種子潔淨度檢查人員的負擔，種子樣品進入潔淨度部門時會依種子標準風選流程進行風選，目的在將較重的潔淨種子與較輕的無生命雜質分離、加速潔淨度檢查、篩除不含種子的種殼、增加實驗室內及實驗室間的結果一致性，適用於種子標準風選流程的作物科別為禾本科部分草類種子，種子風選機須以標準品進行校正，不同種類種子建議分開使用風選機以維持風速設定參數、減少因風選造成之誤差，若風選機數量不足則操作不同作物時要重新以該作物之標準品進行校正。

3. 種子計數器：本課程由種子科學中心種子調製專家 Alan Gaul 講授。各種作物種子的具有不同重量及大小，為決定種子潔淨度檢查的最小需要量，須要將種子數量轉換為較方便計算的重量，種子千粒重資料為計算基礎，種子潔淨度檢查的最小量原則是以 2500 粒種子重量計算，種子以人工方式計數過於耗時且容易出錯，因此發展出種子計數器幫助檢查進行，最簡易的為種子計數板，有固定數量的凹槽，放入種子後將多餘種子倒出及完成計數，少量種子計算或發芽檢查所需的種子數量可以此方式計算，需要計算大量種子時可利用影像感應及影像識別的種子計數器，可以在短時間處理大量種子、準確度高，甚至可以依種子顏色判斷種子批品質，已應用於商業生產上，種子計數器也需要定期校正確保得到正確數據。

(四)　種子檢查概述-潔淨度分析及規則

本課程由種子實驗室主管 Michael Stahr 講授。種子潔淨度檢查是維護種子品質的第一道關卡，主要以人工方式逐粒檢查種子外觀，區別出潔淨種子、其他作物種子、雜草種子及無生命雜質並分別秤重計算其於樣品內所佔比率，作為種子品質評估的依據之一，AOSA 與 ISTA 的種子潔淨度檢查類似，但 AOSA 特別將有害雜草種子檢查獨立出來，因為美國主要以糧食作物栽培為主，面積廣大且採粗放、機械管理，作物種子中若參雜有害雜草種子，播種後難以從田間去除，會危害作物生長，甚至影響自然生態及人體健康，遏止有害雜草種子散播是美國種子法規誕生的主要原因，其種類各州不同，美國於 1974 年通過聯邦有害雜草法（Federal Noxious Weed Act），有害雜草種類由政府定義公告，一般種子潔淨度檢查的最小量是 2500 粒種子重量，有害雜草種子檢查量則放大至 25000 粒種子重量，藉以嚴格管控有害雜草散播。

(五)　重要作物與雜草種子辨識特徵介紹及實作

為本次研習主要課程，由種子實驗室主管 Michael Stahr、分析員 Jassica Wilker Blake 及加拿大食品檢驗局（Canadian Food Inspection Agency, CFIA）種子科學及科技部門（The Seed Science and Technology Section, SSTS）檢驗員 Jennifer Neudorf 聯合講授。課程針對小型豆科、大型豆科、十字花科薹薹屬、菊科、禾本科之草類、穀麥類重要作物種子特徵與相似雜草種子間的辨別進行講述，並搭配個別種子樣品及混合種子樣品給學員觀察及進行潔淨度操作，以下就課程介紹種類簡述：

1.小型豆科：重要作物如紫花苜蓿（*Medicago sativa*）、紅花苜蓿（*Trifolium pretense*）、白三葉草（*Trifolium repens*），相似種子為白花草木樨（*Melilotus alba*）、黃香草木樨（*Melilotus officinalis*）、雜種車軸草（*Trifolium hybridum*），可依種子外型進行辨別。

2. 大型豆科：作物種類多樣如鷹嘴豆（*Cicer arietinum*）、菜豆（*Phaseoulus vulgaris*）、豌豆（*Pisum sativa*）、黃豆（*Glycine max* (L.) Merr.）等，且形狀大小差異較大、相對容易辨識，黃豆品種間可以用種臍顏色、形狀等

特徵進行辨別，區分為淺黃（buff）、黃（yellow）、棕（brown）、灰（grey）、深灰（imperfect black）及黑（black），愛荷華州為美國重要玉米及大豆產區，在潔淨度檢查上會依客戶需求進行大豆品種的辨識；救荒野豌豆（*Vicia sativa*）為牧草及綠肥作物，與其相似的有長柔毛野豌豆（*Vicia villosa*）、紫野豌豆（*Vicia benghalensis*）、多花野豌豆（*Vicia cracca*），種子大小及形狀有些微差異，種皮質地也可作為辨識特徵。

3. 十字花科蕓薹屬：種類繁多且種子外觀相近，包含蔬菜及油料作物，如：西洋油菜(*Brassica napus*)、油菜(*Brassica rapa*)、黑芥(*Brassica nigra*)、芥菜(*Brassica juncea*)、蘿蔔(*Raphanus sativus*)、甘藍(*Brassica oleracea*)，野芥(*Sinapis arvensis*)則為雜草，十字花科蕓薹屬種子相似度很高，較難以形狀及顏色進行辨別，必須於解剖顯微鏡下觀察種皮紋路及種臍特徵。

4.菊科：課程介紹皆為重要入侵雜草，如：加拿大薊(*Cirsium arvense*)、翼薊(*Cirsium vulgare*)、垂花飛廉(*Carduus nutans*)，其種子大小及形狀有較明顯差異，冠毛形態、種子表面花紋、種子基部及頂部連接點形態都可作為分辨依據。

5.草類：在禾本科下有許多牧草及草皮作物，課程中介紹了硬葉偃麥草(*Pascopyrum smithii*)、slender wheatgrass(*Elymus trachycaulus*)、red fescue(*Festuca rubra* ssp. *rubra*)、義大利黑麥草(*Lolium multiflorum*)、中型小麥草(*Thinopyrum intermedium* ssp. *intermedium*)、葦狀羊茅(*Festuca arundinacea*)、鴨茅(*Dactylis glomerata*)，匍匐冰草(*Elymus repens*)為有害雜草，禾本科草類種子形態都很相似，且種子小、附屬物多，主要辨別特徵為外稃、內稃、小穗軸、芒及基部連結處的形態。

禾本科中的金色狗尾草(*Setaria pumila*)、大狗尾草(*Setaria faberi*)、稗(*Echinochloa crusgalli*)、狗尾草(*Setaria viridis*)為常見有害雜草，其種子形態與前述草類有明顯差異，種子呈黃色菱形，可依大小

及表面紋路進行辨識。

另外介紹了車前草科車前草屬的大車前草(*Plantago major*)、美洲車前草(*Plantago rugelii*)、芒苞車前(*Plantago aristata*)及長葉車前草(*Plantago lanceolata*)，車前草是常見分布廣泛的雜草種類，其中長葉車前草為有害雜草，車前草種子呈細長形或菱形，可用形狀、表皮紋路及種子背面凹痕進行分辨。

6.穀麥類：課程介紹裸麥(*Secal cerale*)、小麥(*Triticum aestivum*)、燕麥(*Avena sativa*)及大麥(*Hordeum vulgare*)，皆為常見且重要的糧食作物，去殼前可依外稃、內稃、小穗軸、芒及基部連結處的形態判斷，去殼後可透過種子形狀、表皮特徵、絨毛及種子凹痕來辨識。

(六) ISU 種子檢查室

ISU 種子檢查實驗室成立已超過百年，為世界最大官方種子檢查實驗室也是美國官方首間通過 ISO 9001 認證的實驗室，提供 300 種以上糧食、蔬菜、花卉、樹木種子室內檢查，每年申請案統計約有 120 種左右作物，檢查項目包含水分含量、潔淨度、發芽率、種子活力等，種子健康檢查部分則有超過 350 種種子病原檢測服務，愛荷華州位在美國中西部，生產作物以玉米及大豆為主，約占申請案件 6 成，因此基改檢測也為重要項目之一，針對種子檢查及種子調製每年舉辦相關訓練課程，以滿足顧客的需求，未來預計會取得 ISO 17025 及 ISTA 認證。

肆、心得及建議

一、 本場種子檢查室依循 ISTA 國際規範執行檢查業務，除每年更新 ISTA 檢查規則版本也須了解最新檢查技術及訊息，因此派送檢查室同仁參與相關研習及年會等活動是提升專業之能與精進檢查技術的有效途徑，尤其是與世界各國種子檢查專業人員進行交流，更可以汲取其它實驗室的經驗作為改善參考，未來若有計畫經費支持可持續參與國際研習課程及相關年會，並於出國前詢問、整理本場種檢室同仁日常檢查業務上遇到與研習項目相關之問題或困難，藉研習與年會等專業人士

聚集場合與國外檢查室人員討論、交流、經驗分享，可以更直接、準確提升檢查專業能力。

二、 目前 ISTA 及 AOSA 潔淨度檢查仍以人工用肉眼或使用放大鏡或顯微鏡方式觀察種子外觀為主，潔淨度檢查需長時間專注於細小的種子上，現行種檢室使用傳統檢查台，檢查人員低頭檢視種子，頸椎及背部脊椎承受較大壓力，長期固定姿勢可能造成傷害，亦有可能因眼睛、肩頸疲勞影響檢查效率及造成失誤，未來長期目標希望逐步以影像辨識系統取代人工檢查，但在目前以人工進行潔淨度檢查時可考慮增設顯微鏡攝影設備搭配螢幕，將種子檢查台操作的種子影像即時投放於螢幕上，可放大種子影像更易於檢查進行及提升辨識準確度，減輕檢查人員眼睛及肩頸負擔、方便討論進行，種子發芽及活力檢測也可使用。

三、 潔淨度檢查時可能遇到未知種子，此時可利用圖鑑或標本去比對找出正確植物種類，圖鑑上種子大小、顏色與實際可能有落差，利用種子標本較容易進行比對，而 ISTA 能力測試使用的作物不一定是日常檢查常見的種類，在參與 ISTA 能力測試前取標本種子先行練習有助於熟悉測試種類，標本收集對於潔淨度檢查有極大幫助，ISU 種子檢查室有專門標本櫃放置種子標本，當參與課程學員詢問一些未在課表內的作物種類，講師就會拿出標本給學員觀察比對後再進行討論，而針對 AOSA 潔淨度測驗考題種類也裝在培養皿內供學員隨時複習，是很有效率的學習方式；種子檢查作物種類多元，部分國外重要作物在臺灣並不常見，於市場上無法輕易購得，建議可列出重要作物種子清單、排定順序，向國家種原庫提出申請或是自國外引種以增加種子檢查室種子標本庫種類、幫助檢查進行。

四、 配合政府近年重要政策「大糧倉計畫」及「新南向政策」，建議可針對各種類雜糧作物建立種子品種鑑定、活力檢測等相關國家標準檢測方法，以因應未來栽培面積增加時的高品質種子需求；另可以自身經驗輔導南向國家成立種子檢查室並通過 ISTA 等國際認證，使台灣種苗商於當地生產的種子可直接由當地種子檢查室進行檢查後出口，節省運輸成本。

伍、研習照片

<table>
<tr><td>  </td><td> 
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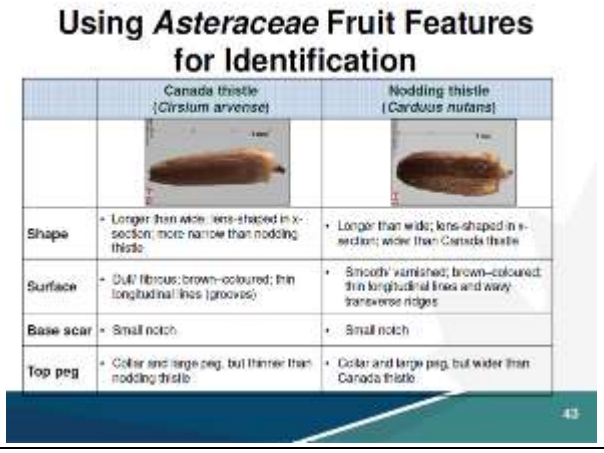
<tr><td>ISU 種子科學大樓外觀</td><td>ISU 種子實驗室外種子貼畫</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>ISU 種子實驗室認證證書</td><td>上課教室內每位學員皆有工具及顯微鏡進行種子潔淨度檢查練習</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>種子分樣器</td><td>教室內擺放種子檢查等手冊供學員查閱</td></tr>
</table>

	
各科種子標本分類擺放供學員觀察	種子標本放置於培養皿中
	
分析員 Jassica Wilker Blake 講解湯匙法取樣操作流程	講解種子潔淨度檢查操作及注意事項
	
紫花苜蓿種子樣品檢查操作，其中混入紅花苜蓿、白花草木樨及黃香草木樨	白三葉草（左）與雜種車軸草（右）辨別操作後的樣品與標本

	
種子科學中心種子調製專家 Alan Gaul 介紹 ISU 種子調製部門	介紹傳統種子計數板的使用及限制
	
影像感應種子計數器可將同時落下的種子正確計數	影像識別種子計數器擷取種子影像後可依顏色進行種子批品質評估
	
具學習功能的種子計數器，可找出不同種子最適合的下落速度以精準計數	螺旋種子計數器且具有定量分裝功能

	
各種類種子有固定使用的種子風選機，可減少校正次數	校正風選機的種子標準品須放置於乾燥缸內維持種子水分含量
	
硬葉偃麥草、有害雜草匍匐冰草與 slender wheatgrass（左至右）的種子辨識	creeping red fescue、黑麥草及葦狀羊茅(左至右）種子標本
	
鴨茅樣品潔淨度檢查後挑出的無生命雜質（左上）、其他種子（右上）與潔淨種子（左下）	以中型小麥草樣品進行複合種子單元與單一種子單元的區別練習，左上為無生命雜質、中間及右下為單一種子單元、右上為複合種子單元

	
裸麥、小麥、燕麥及大麥（左至右）混合樣品操作後分類擺放	黑小麥、小麥與硬粒小麥（左至右）標本外觀比較
	
大豆種臍顏色分類（一）	大豆種臍顏色分類（二）
	
西洋油菜、野芥與油菜（左至右）混合樣品分類後與標本比較，其實不易分辨差異	顯微鏡下西洋油菜與油菜的種皮紋路及種臍明顯不同

	
有害雜草加拿大薊、翼薊、垂花飛廉（左至右）種子辨識分類後與標本比對	顯微鏡下加拿大薊與垂花飛廉種子可透過形狀、表面紋路、基部與頂部接觸點痕跡特徵辨識
	
絳三葉披衣種子潔淨度檢查練習，左下為其他作物種子、中為潔淨種子、右上為無生命雜質、右下為披衣不完整種子	美國種子商品標籤需詳細載明品質資訊
	
ISU 種子登記部門，中間長桌可進行樣品整理，完成後置於側邊架子上等待後續流程	ISU 潔淨度部門的種子陳列展示

	
ISU 潔淨度部門種子標本櫃	顯微鏡攝影設備搭配螢幕提升檢查效率
	
ISU 發芽部門種植操作台，配合不同作物有各式計數盤供發芽試驗使用	放置發芽盤的櫃子，可視作物種類及生長需求調整高度間隔
	
發芽介質加水設備，半自動化加入定量去離子水	紙上法使用的 creped cellulose paper

	
ISU 發芽部門的 20℃ 發芽育苗室	蔬菜種子以捲紙法進行發芽測試
	
發芽育苗室以直立日光燈管搭配發芽櫃透明壓克力背板提供幼苗光源	發芽櫃各自獨立且密閉，種子健康檢查與發芽檢查可共用育苗室，以櫃上白板做區隔
	
玉米發芽紙上法（上）及沙床法（下）	大豆幼苗生長情形

	
發芽櫃最下層放置吸水介質保持濕度	大豆發芽沙床法（上）及紙上法（下）
	
種子健康檢查培養盒	ISU 種子健康檢查部門細菌震盪培養
	
ISU 基改作物檢測部門	抗殺草劑嘉磷塞大豆與一般大豆檢測

陸、附錄

一、 課程表

2018 Purity Week – Seed Analyst Short Course
Iowa State University Seed Lab

Monday	**April 30 2018**	
8:00-8:15	Welcome and Introductions. Overview of week	Stahr
8:15 -9:00	**Lecture & Lab**: Sampling	
9:00-9:45	**Demonstration**: Getting Working Samples (Mechanical & Hand Dividing)	Arora
9:45-10:05	Break	
10:05 – 10:35	**Demonstration**: Conducting Examinations. Available Resources.	Blake
10:35-11:15	**Lecture**: Structures: Inflorescence, Flower, and Seed Structure	
11:15 – 12:00	**Lecture**: ID Features of Fabaceae	
12:00 – 1:00	Lunch	
1:00 – 1:45	**Lecture**: Taxonomy. Using Keys	Lewis
1:45 – 3:00	**Lab Practice**: Soybeans (sample 1) **Lecture & Lab**: Small-Seeded Legumes (alfalfa, clovers) (sample 3,4, 8. Experienced - 6, 13)	Staff
3:00 – 3:15	Break	
3:15 – 4:00	**Lab Practice**: Crownvetch (sample 14)	Staff
4:00 – 5:00	**Lecture**: Seed Count Procedure **Demo**: Mechanical & Electronic Imaging Seed Counters	Stahr Gaul ?
Tuesday	**May 1, 2018**	
8:00 – 9:00	**Lecture**: Overview of Seed Testing. Purity Analysis and Rules	Stahr
9:00 – 10:00	**Lecture**: ID features of Grasses & Application to Selected Species	"Neudorf"
10:00 -10:20	Break	
10:20 - 11:20	**Lab Practice**: Ryegrass & Fescues (sample 7, Experienced- 17) Quackgrass & Wheatgrasses (Sample 10)	Staff
11:20 – 12:10	**Lecture & Lab**: Cereals (sample 2. Experienced 11 & 12)	Staff
12:10 – 1:00	Catered Lunch with ISU Seed Lab Staff	

2018 Purity Week – Seed Analyst Short Course
Iowa State University Seed Lab

1:00-2:00	**Lecture:** Uniform Blowing Procedure **Lab**: Seed blowers	
2:00 – 3:00	**Lecture**: Multiple Unit Procedure	
3:00-3:20	Break	
3:20 – 5:00	**Lab Practice**: Lawn grass seed mix (sample 25) Prairie seed mix (sample 26) Full Weight Purity Test Samples	
Wednesday	**May 2, 2017**	
8:00-9:00	**Lecture**: Seed Certification **Lab**: Hilum checks, etc.	Cornelious
9:00 – 9:30	**Lecture**: Cultivar Purity	
9:30 – 10:00	**Lecture**: Information on AOSA & SCST Consolidated Exams	
10:00-10:20	**Break**	
10:20-11:20	**Lecture**: Identification features of Brassica species	"Neudorf"
11:20-12:00	**Lab Practice**: Working with Brassicas	
12:00-1:00	Lunch	
1:00 – 1:45	**Lecture**: Pelleted, Coated, or Encrusted Seeds	
1:45 – 2:40	**Lecture**: Identification of Asteraceae **Lab Practice**	
2:40 – 3:00	Break	
3:00-4:00	**Lecture & Practice**: Purity Tolerances	Stahr
4:00-5:00	**Lab Practice**	Staff
Thursday	**May 3, 2018**	
8:00 – 8:45	**Lecture:** Report of Analysis/Seed Laws	
8:45 - 10:00	Practice Written and ID Exams	
10:00 -10:20	Break	

2018 Purity Week – Seed Analyst Short Course
Iowa State University Seed Lab

10:20 – 11:30	Review Exams. Discussion.	Arora
11:30 – 12:00	Certificates. Discussion	
12:00 – 1:00	Catered Lunch – Pizza & Salad	
1:00-4:30	Optional lab time. Other topics.	

Appendix D. AOSA Rules for Testing Seeds

AOSA Rules for Testing Seeds – Section 2: Preparation of Working Samples

Volume 1. Principles and Procedures

(Provided by the Association of Official Seed Analyst)

SECTION 2: PREPARATION OF WORKING SAMPLES

The laboratory analysis for law enforcement, labeling, and general information as to seed quality, should determine the following for the sample analyzed: (1) the purity composition, (2) the rate of occurrence of noxious-weed seeds per unit weight, and (3) the percentage germination of the pure seed under consideration. Additional information, such as, seed count, detection of seed treatment, bulk examination for contaminants, tetrazolium viability, detection of fungal endophtyes, and seed moisture content may be determined using approved procedures.

2.1 Definitions

(1) **Seed unit:** the structure usually regarded as a seed in planting practices and in commercial channels. Refer to section 3.2 e for pure seed unit descriptions.

(2) **Working samples:**

(a) **Purity working sample:** the sub-sample taken from the submitted sample on which the purity analysis is performed.

2.2 Obtaining the working sample

The working sample on which the actual analysis is performed shall be taken from the submitted sample in such a manner that it will be representative. A suitable type of mechanical divider (conical, centrifugal, riffle, etc.) should be used. To avoid damage when dividing large-seeded crop kinds such as beans, peas, etc., prevent the seeds from falling great distances onto hard surfaces.

a. **Mechanical dividers.** – This method is suitable for most kinds of seeds. The apparatus divides a sample into two approximately equal parts. The submitted sample is mixed by passing it through the divider, recombining the two parts and passing the whole sample through a second time and similarly a third time. After mixing, the sample shall be reduced by passing the seed through the divider repeatedly, removing half the sample on each occasion. This process of successive halving is continued until a working sample of approximately, but not less than the minimum weight(s) stated in Table 2A is obtained.

Use of compressed air or a vacuum is highly recommended for cleaning mechanical dividers.

(1) **Centrifugal divider (Gamet type)**: This divider is suitable for all kinds of seed though it is not recommended for oilseeds (such as rapeseed, canola, mustards, flax) and kinds susceptible to damage (such as peas, soybeans, etc) and the extremely chaffy types.

The divider makes use of centrifugal force to mix and scatter seeds over the dividing surface. The seed flows downward through a hopper onto a shallow rubber cup or spinner. Upon rotation of the spinner by an electric motor the seeds are thrown out by centrifugal force and fall downward. The circle or area where the seeds fall is equally divided into two parts by a stationary baffle so that approximately half the seeds fall in one spout and half in the other spout. The centrifugal divider tends to give variable results when not carefully operated, and therefore the following procedure must be used:

(a) Preparation of the apparatus:
  (i) Level the divider using the adjustable feet.
  (ii) Check the divider and four containers for cleanliness. Note that seeds can be trapped under the spinner and become a source of contamination.

(b) Sample mixing:
  (i) Place a container under each spout.
  (ii) Feed the whole sample into the hopper; when filling the hopper, the seed must always be poured centrally.
  (iii) After the sample has been poured into the hopper, the spinner is operated and the seed passes into the two containers. Turn off spinner.
  (iv) Full containers are replaced by empty containers. The contents of the two full containers are fed centrally into the hopper together, the seed being allowed to blend as it flows in. The spinner is operated.
  (v) The sample mixing procedure is repeated at least once more.

(c) Sample reduction:
  (i) Full containers are replaced by empty containers. The contents of one full container are set aside and the contents of the other container are fed into the hopper. The spinner is operated.
  (ii) The successive halving process is continued until the working sample(s) of not less than the minimum weight(s) required stated in Table 2A are obtained.
  (iii) Ensure that the divider and containers are clean after each mixing operation.

(2) **Soil/Riffle divider**: This divider is suitable for most kinds of seed. For round-seeded kinds such as *Brassica* species, the collection containers should be covered to prevent the seeds from bouncing out.

This divider consists of a hopper with attached channels or ducts, a frame to hold the hopper, four collection containers and a pouring pan. Ducts or channels lead from the hopper to the collection containers, alternate ones leading to opposite sides. Riffle dividers are available in different sizes for different sizes of seed. The width and number of channels and spaces are important. The minimum width of the channels must be at least two times the largest diameter of the seed or any possible contaminants being mixed.

This apparatus, similar to the centrifugal divider, divides the sample into approximately equal parts.

(a) Preparation of the apparatus:
  (i) Place the riffle divider on a firm, level clean surface. Ensure the divider is level.
  (ii) Ensure that the divider and the four sample collection containers are clean. Check all channels, joints and seams of the divider and collection containers to ensure there are no seeds or other plant matter present before each use.
  (iii) Two clean empty collection containers shall be placed under the channels to receive the mixed seed.

(b) Sample mixing:
  (i) Pour the whole sample into the divider by running the seed backwards and forwards along the edge of the divider so that all the channels and spaces of the divider receive an equal amount of seed.
  (ii) The two full containers shall be replaced with two clean empty containers.
  (iii) The contents of one full container shall be poured into the divider by holding the long edge of the pan against the long edge of the riffle hopper and then rotating the bottom up so that the seeds pour across all channels at the same time, followed by the other full container using the same procedure.
  (iv) This process of mixing the entire submitted sample shall be repeated at least one more time before successive halving begins.

(c) Sample reduction:
  (i) The contents of one full container are set aside. Empty containers are placed under each channel, and the contents of the other container is poured into the hopper by holding the long edge of the pan against the long edge of the riffle hopper and then rotating the bottom up so that the seeds pour across all channels at the same time.
  (ii) The successive halving process is continued until the working sample(s) of not less than the minimum weight(s) required stated in Table 2A are obtained.
  (iii) Ensure that the divider and collection containers are clean after each mixing operation. Check all channels of the divider, the joints and seams.

(3) **Boerner divider:** This divider is suitable for most kinds of seed, including chaffy species, peas, beans, soybeans, etc.

This divider consists of a hopper, a cone, and a series of baffles which direct the seed into two spouts. The baffles are arranged in a circle at the top and form equal width alternate channels and spaces. The channels lead to one spout, the spaces to the other. The width and number of channels and spaces are important. Five channels and spaces should be regarded as a minimum. The more channels the better but the minimum width of the channels must be at least two times the largest diameter of the seed or any possible contaminants being mixed.

(a) Preparation of the apparatus: Ensure that the divider and the two sample collecting pans are clean.
(b) Sample mixing:
  (i) Place a collecting pan under each spout.
  (ii) Close the valve at the bottom of the divider.
  (iii) Pour the seed centrally into the hopper.

(iv) Quickly open the valve. Gravity will distribute the seed evenly through the channels and spaces.
(v) To mix the seed, repeat the steps at least twice for free flowing seed and three times for chaffy grasses.

(c) Sample reduction: The contents of one full collection pan are set aside. Repeat steps in 2 "sampling mixing". To improve the randomness of reduction, choose collection pans from alternate sides for the successive halving process. The successive halving process is continued until the working sample(s) of not less than the minimum weight(s) required stated in Table 2A are obtained.

b. **Non-mechanical methods.**

(2) **Hand-halving method:** This method can be used when a proper mechanical divider is not available.

Procedure:
(a) Seed is poured evenly onto a clean smooth surface.
(b) The sample shall be thoroughly mixed using a flat-edged spatula and placed into a pile.
(c) The pile shall be divided in half using a straight edge or ruler.
(d) Each half portion is divided in half.
(e) Each of the portions is divided into half again. There are now eight portions.
(f) Arrange the eight portions into two rows of four.
(g) Alternate portions should be combined to obtain two halves e.g. combine the first portion from row 1 with the second portion from row 2. Remove the remaining four portions.
(h) Repeat steps (a) to (g) until sufficient portions of seed are taken to constitute a working sample(s) of not less than the minimum weight(s) required stated in Table 2A are obtained.

2.3 Size of working samples.

a. **Weighing the working sample.** – The weight of the working sample shall be determined to the number of decimal places indicated below:

Weight of Working Sample in Grams	Number of Decimal Places
Less than 1.000	4
1.000 to 9.999	3
10.00 to 99.99	2
100.0 to 999.9	1
1000 or more	0

AOSA Rules for Testing Seeds – Section 12: Mechanical Seed Count

Volume 1. Principles and Procedures

(Provided by the Association of Official Seed Analyst)

SECTION 12: MECHANICAL SEED COUNT

The following method shall be employed when using a mechanical seed counter to determine the number of seeds contained in a sample of soybean (*Glycine max*), corn (*Zea mays*), wheat (*Triticum aestivum*) and field bean (*Phaseolus vulgaris*).

12.1 Samples.

Samples for testing shall be of at least 500 grams for soybean, corn and field beans and 100 grams for wheat and received in moisture proof containers. Samples shall be retained in moisture proof containers until the weight of the sample prepared for purity analysis is recorded.

12.2 Seed counter calibration.

The seed counter shall be calibrated daily prior to use.

(a) Prepare a calibration sample by counting 10 sets of 100 seeds. Visually examine each set to insure that it contains whole seeds. Combine the 10 sets of seeds to make a 1,000 seed calibration sample. The seeds of the calibration sample should be approximately the same size and shape as the seeds in a sample being tested. If the seeds in a sample being tested are noticeably different in size or shape from those in the calibration sample, prepare another calibration sample with seeds of the appropriate size and shape. Periodically re-examine the calibration samples to insure that no seeds have been lost or added.

(b) Carefully pour the 1,000 seed calibration sample into the seed counter. Start the counter and run it until all the seeds have been counted. The seeds should not touch as they run through the counter. Record the number of seeds as displayed on the counter read out. The seed count should not vary more than ±2 seeds from 1,000. If the count is not within this tolerance, clean the mirrors, adjust the feed rate and/or reading sensitivity. Rerun the calibration sample until it is within the ±2 seed tolerance. If the seed counter continues to fail the calibration procedure and the calibration sample has been checked to ensure that it contains 1,000 seeds, do not use the counter until it has been repaired.

12.3 Sample preparation.

Immediately after opening the moisture proof container, mix and divide the submitted sample, in accordance with section 2.2, to obtain a sample for purity analysis and record the weight of this sample in grams to the appropriate number of decimal places (refer to section 2.3 a). Conduct the purity analysis to obtain pure seed for the seed count test.

12.4 Conducting the test.

After the seed counter has been calibrated, test the pure seed portion from the purity test and record the number of seeds in the sample.

12.5 Calculation of results.

Calculate the number of seeds per pound to the nearest whole number using the following formula:

$$\text{Number of seeds per pound} = \frac{453.6\ g/lb \times \text{no. of seeds counted}}{\text{weight (g) of sample analyzed for purity}}$$

12.6 Tolerances for results from different laboratories.

Multiply the labeled seed count or first seed count test result by four percent for soybean samples, two percent for corn (round, flat or plateless) samples, five percent for field bean samples and three percent for wheat samples. Express the tolerance (the number of seeds) to the nearest whole number. Consider the results of two tests in tolerance if the difference, expressed as the number of seeds, is equal to or less than the tolerance.

Example:

Kind of seed: Corn
Label claim (1st test): 2275 seed/lb.

Lab Test (2nd test): Purity working weight = 500.3 g
Seed count of pure seed = 2479 seeds

$$\text{Number of seeds per pound} = \frac{453.6\ g/lb \times 2479\ seeds}{500.3\ g} = 2247.6\ seeds/lb$$

Rounded to the nearest whole number = 2248 seeds/lb

Calculate tolerance value for corn:

multiply label claim by 2%
2275 seeds/lb × 0.02 = 45.5 seeds/lb;
rounded to the nearest whole number = 46 seeds/lb

Determine the difference between label claim and lab test:

2275 seeds/lb – 2248 seeds/lb = 27 seeds/lb

The difference between the lab test (2nd test) and the label claim (1st test) is less than the tolerance
(27 < 46); therefore, the two results are in tolerance.

三、 AOSA & SCST 綜合測驗資訊及內容

AOSA & SCST CONSOLIDATED EXAM INFORMATION & CONTENT

Qualifications & Administration

	Consolidated Exam
Requirements	Currently employed in seed testing. 2 years full time experience, equivalent to 4000 hours. Or equivalent as determined by Exam Committee
Qualifications	100 points: work experience, workshops, and acceptable college courses. Written recommendation by trainer/tutor that the applicant is competent to take the exam and become an accredited analyst.
Herbarium	150 seed herbarium collection reviewed at exam or voucher from lab supervisor that lab has a herbarium with at least 150 kinds of seed: common crops, federal and state noxious weeds. The voucher form must describe how the herbarium is organized.
Application	Submitted to Executive Director Approved by Exam Committee
Exam Fee	$300 for individual exam (either purity or germination) $500 for purity and germination
Location & Frequency	Once a year in each region (as needed), hosted by an approved/designated AOSA or SCST member lab, or at the annual meeting (can take the place of a regional exam).
Grading	Completed written and practical exams are sent to Executive Director, exams are coded and distributed to graders (at least 2 committee members grade each exam, reviewed by chairs).
Passing Grades	≥70% written exam ≥80% practical exam ≥80% overall average
Titles	No change, each organization maintains current titles and membership categories.

Key Exam References

Please note that the AOSA/SCST RST/CVT/CPT/CSA Study Guide specifies the level and detail of knowledge expected for the references listed below (Candidates are not expected to memorize the ISTA Rules or Canadian Methods & Procedures but should be able to identify key differences between AOSA, ISTA and the Canadian M&P.)

Reference	Consolidated Exam
AOSA Rules Vol. 1, 2, 3, 4 (updated annually 10/1)	Sampling procedures Sample preparation Purity examination procedures Noxious weed examination procedures Germination procedures Uniform Blowing Procedures Uniform Classification of Crop & Weed Seeds Seedling Evaluation Handbook Calculating Multiple Seed Units (MSU) Florescence test procedures Seed count procedures (hand and mechanical methods) Moisture testing Calculating final results Reporting results
AOSA Handbooks	AOSA Seed Vigor Handbook, 2010 AOSA Tetrazolium Testing Handbook, 2009 AOSA Moisture Testing Handbook, 2007 AOSA Cultivar Purity Handbook
Seed ID List	List of 311 species provided by Exam Committee and included with the Study Guide.
Other Methods or Rules	Federal Seed Act Regulations: key concepts All States Noxious Weed Seed List Canadian Methods & Procedures: key concepts ISTA Rules for Testing Seeds: key concepts
Other	AOSA/SCST RST/CVT/CPT/CSA Study Guide SCST Seed Technologist Training Manual, 2005 Seed Technology DVDs AOSA Seed Analyst Training Manual (out of print) Principles of Seed Science and Technology, Copeland & McDonald A good botany book for flower and seed structures USDA Handbook 30: Manual for Testing Agricultural and Vegetable Seeds USDA Handbook 219: Identification of Crop and Weed Seeds

Purity Exam Content

Written Exam	Content
Points	155
Time	2 hours
References	Provided with exam as needed
Written Content	Exam composed from pool of questions based on key exam references: sampling, examinations, classification, blowing procedure, definitions, etc. Genus and specific epithet for 25 common names (40 scientific names will be given, examinee will match common with scientific name). Basic botany and plant family characteristics. Compute weight of the working sample for a mixture. Report of analysis exercises. Multiple Seed Unit and calculation
Practical Exam	**Content**
Points	205
Time	6 hours
References	Provided with exam as needed
Mix & Divide	Demonstrate the correct technique to mix, divide, and weigh a sample. Sample, checklist & references provided. (5 points)
Seed ID	50 samples of seed from the Seed Identification List, identify the species using the scientific or common name. No references allowed. (100 points, 1 point for correct Genus only, 2 points for Genus and specific epithet or complete common name)
Separations	Complete 2 out of 5 samples of 25 seed mixture separations. No references allowed. (50 points)
Purity Sample	Complete a purity analysis on a sample: separate components, identify & classify contaminants, weigh and compute % of components. References provided (Vol. 3, sections of Rules needed for exercise). Choice of three species to conduct purity. (20 points)
PSU Classification Calculate MSU	Classify Objects found in a hypothetical sample, MSU classification (this is a virtual exam). References provided (20 points for correct classification). Example included in study guide. (20 points).
Uniform Blowing Procedure	Demonstrate use of Uniform Blowing Point. Checklist & References provided. (10 points)

四、 AOSA 種子辨識列表

Family	Genus	Specific epithet	common names
Aizoaceae	*Tetragonia*	*tetragonioides*	New Zealand spinach
Amaranthaceae	*Amaranthus*	*albus*	tumble pigweed
Amaryllidaceae	*Allium*	*canadense*	wild onion, wild bulbous onion
Amaryllidaceae	*Allium*	*cepa*	onion
Amaryllidaceae	*Allium*	*fistulosum*	Welsh onion
Amaryllidaceae	*Allium*	*porrum*	leek
Amaryllidaceae	*Allium*	*schoenoprasum*	chives
Amaryllidaceae	*Allium*	*vineale*	wild garlic
Apiaceae	*Anethum*	*graveolens*	dill
Apiaceae	*Apium*	*graveolens*	celery
Apiaceae	*Carum*	*carvi*	caraway, wild caraway
Apiaceae	*Conium*	*maculatum*	poison hemlock
Apiaceae	*Coriandrum*	*sativum*	coriander
Apiaceae	*Daucus*	*carota*	carrot
Apiaceae	*Pastinaca*	*sativa*	parsnip; wild parsnip
Apiaceae	*Petroselinum*	*crispum*	parsley
Apocynaceae	*Asclepias*	*syriaca*	common milkweed
Asparagaceae	*Asparagus*	*officinalis*	asparagus
Asteraceae	*Achillea*	*millefolium*	common yarrow, woolly yarrow, western yarrow
Asteraceae	*Ambrosia*	*artemisiifolia*	common ragweed
Asteraceae	*Ambrosia*	*trifida*	giant ragweed
Asteraceae	*Anthemis*	*arvensis*	field chamomile
Asteraceae	*Anthemis*	*cotula*	dogfennel, mayweed
Asteraceae	*Arctium*	*lappa*	great burdock
Asteraceae	*Carduus*	*nutans*	musk thistle, nodding thistle
Asteraceae	*Carthamus*	*tinctorius*	safflower
Asteraceae	*Centaurea*	*cyanus*	cornflower, bachelor's button, ragged robin
Asteraceae	*Centaurea*	*solstitialis*	yellow starthistle
Asteraceae	*Cichorium*	*endivia*	endive
Asteraceae	*Cirsium*	*arvense*	Canada thistle
Asteraceae	*Cirsium*	*undulatum*	wavyleaf thistle
Asteraceae	*Cirsium*	*vulgare*	bull thistle
Asteraceae	*Crepis*	*capillaris*	smooth hawksbeard
Asteraceae	*Cynara*	*cardunculus*	artichoke, cardoon, artichoke thistle
Asteraceae	*Helianthus*	*annuus*	common sunflower, wild sunflower
Asteraceae	*Helianthus*	*ciliaris*	blueweed, Texas blueweed
Asteraceae	*Helminthotheca*	*echioides*	bristly ox-tongue
Asteraceae	*Hypochaeris*	*radicata*	spotted cat's-ear
Asteraceae	*Iva*	*axillaris*	poverty weed, poverty sumpweed, mouse-ear poverty weed
Asteraceae	*Lactuca*	*sativa*	lettuce
Asteraceae	*Leucanthemum*	*vulgare*	oxeye daisy, Shasta daisy
Asteraceae	*Onopordum*	*acanthium*	Scotch thistle, cotton thistle
Asteraceae	*Rhaponticum*	*repens*	Russian knapweed
Asteraceae	*Rudbeckia*	*hirta*	black-eyed-Susan, hairy coneflower

Family	Genus	Specific epithet	common names
Asteraceae	*Sonchus*	*arvensis*	perennial sowthistle
Asteraceae	*Sonchus*	*asper*	spiny sowthistle, spring sowthistle
Asteraceae	*Sonchus*	*oleraceus*	annual sowthistle
Asteraceae	*Taraxacum*	*officinale*	dandelion
Asteraceae	*Tragopogon*	*porrifolius*	oysterplant, salsify
Asteraceae	*Tragopogon*	*pratensis*	yellow goatsbeard, meadow salsify
Asteraceae	*Tripleurospermum*	*inodorum*	scentless mayweed
Asteraceae	*Xanthium*	*strumarium*	common cocklebur
Boraginaceae	*Amsinckia*	*tessellata*	western fiddleneck
Boraginaceae	*Buglossoides*	*arvensis*	corn gromwell, field gromwell
Boraginaceae	*Echium*	*vulgare*	blueweed
Boraginaceae	*Lappula*	*squarrosa*	bluebur, European stickseed
Brassicaceae	*Barbarea*	*verna*	upland cress, early wintercress
Brassicaceae	*Barbarea*	*vulgaris*	bitter wintercress, yellowrocket
Brassicaceae	*Berteroa*	*incana*	hoary alyssum
Brassicaceae	*Brassica*	*juncea*	brown mustard, India mustard, Indian mustard
Brassicaceae	*Brassica*	*napus*	annual rape, winter rape, (Argentine type rapeseed, oilseed rape, canola), forage rape
Brassicaceae	*Brassica*	*nigra*	black mustard, wild mustard
Brassicaceae	*Brassica*	*oleracea*	broccoli, cauliflower
Brassicaceae	*Brassica*	*rapa*	annual turnip rape, biennial turnip rape, bird rape, turnip
Brassicaceae	*Camelina*	*microcarpa*	littleseed falseflax
Brassicaceae	*Camelina*	*sativa*	bigseed falseflax; camelina
Brassicaceae	*Capsella*	*bursa-pastoris*	shepherd's-purse
Brassicaceae	*Crambe*	*hispanica*	crambe
Brassicaceae	*Lepidium*	*campestre*	field peppergrass, field peppercress, field pepperweed
Brassicaceae	*Lepidium*	*draba*	heart-podded hoarycress, whitetop
Brassicaceae	*Lepidium*	*sativum*	garden cress
Brassicaceae	*Nasturtium*	*officinale*	watercress
Brassicaceae	*Raphanus*	*raphanistrum*	wild radish
Brassicaceae	*Raphanus*	*sativus*	radish
Brassicaceae	*Rapistrum*	*rugosum*	common giant mustard, turnipweed
Brassicaceae	*Sinapis*	*alba*	white mustard
Brassicaceae	*Sinapis*	*arvensis*	charlock, field mustard, wild mustard, wild turnip
Brassicaceae	*Thlaspi*	*arvense*	fanweed, Frenchweed, field pennycress
Caryophyllaceae	*Agrostemma*	*githago*	corncockle
Caryophyllaceae	*Silene*	*latifolia*	white campion, white cockle
Caryophyllaceae	*Silene*	*noctiflora*	night-flowering catchfly
Caryophyllaceae	*Silene*	*vulgaris*	bladder campion, cowbell campion
Caryophyllaceae	*Stellaria*	*media*	common chickweed
Caryophyllaceae	*Vaccaria*	*hispanica*	cow-cockle
Chenopodiaceae	*Atriplex*	*canescens*	fourwing saltbush
Chenopodiaceae	*Bassia*	*scoparia*	kochia
Chenopodiaceae	*Beta*	*vulgaris*	beet, field beet, sugar beet, Swiss chard, mangel

Family	Genus	Specific epithet	common names
Chenopodiaceae	*Chenopodium*	*album*	common lamb's-quarters
Chenopodiaceae	*Salsola*	*tragus*	common Russian-thistle, tumbling Russian-thistle
Chenopodiaceae	*Spinacia*	*oleracea*	spinach
Convolvulaceae	*Calystegia*	*sepium*	hedge bindweed
Convolvulaceae	*Convolvulus*	*arvensis*	field bindweed
Convolvulaceae	*Cuscuta*	*pentagona*	field dodder
Convolvulaceae	*Dichondra*	*repens*	dichondra
Convolvulaceae	*Ipomoea*	*hederacea*	ivyleaf morning-glory
Convolvulaceae	*Ipomoea*	*purpurea*	tall morning-glory, wild morning-glory, woolly morning-glory
Cucurbitaceae	*Citrullus*	*lanatus*	watermelon
Cucurbitaceae	*Cucumis*	*melo*	muskmelon, cantaloupe, honeydew
Cucurbitaceae	*Cucumis*	*sativus*	cucumber
Cucurbitaceae	*Cucurbita*	*maxima*	mammoth pumpkin, winter large squash
Cucurbitaceae	*Cucurbita*	*pepo*	small gourd, common pumpkin, acorn squash, summer squash
Cyperaceae	*Cyperus*	*esculentus*	yellow nutgrass, yellow nutsedge
Cyperaceae	*Cyperus*	*rotundus*	purple nutgrass, purple nutsedge
Euphorbiaceae	*Acalypha*	*virginica*	three-seeded mercury
Euphorbiaceae	*Euphorbia*	*esula*	leafy spurge
Euphorbiaceae	*Euphorbia*	*maculata*	spotted spurge
Euphorbiaceae	*Ricinus*	*communis*	castorbean
Fabaceae	*Aeschynomene*	*indica*	ding ding, curly indigo, Indian jointvetch, northern jointvetch, sensitive jointvetch
Fabaceae	*Arachis*	*hypogaea*	peanut
Fabaceae	*Chamaecrista*	*fasciculata*	partridge pea
Fabaceae	*Cicer*	*arientinum*	chickpea, garbanzo bean
Fabaceae	*Cyamopsis*	*tetragonaloba*	guar
Fabaceae	*Glycine*	*max*	soybean
Fabaceae	*Kummerowia*	*stipulacea*	Korean lespedeza
Fabaceae	*Kummerowia*	*striata*	common lespedeza, striate lespedeza
Fabaceae	*Lathyrus*	*hirsutus*	rough-pea
Fabaceae	*Lathyrus*	*sylvestris*	flat-pea
Fabaceae	*Lens*	*culinaris*	lentil
Fabaceae	*Lespedeza*	*cuneata*	Chinese lespedeza, sericea lespedeza
Fabaceae	*Lotus*	*corniculatus*	birdsfoot trefoil
Fabaceae	*Lotus*	*uliginosus*	big trefoil
Fabaceae	*Medicago*	*lupulina*	black medic
Fabaceae	*Medicago*	*sativa*	alfalfa, lucerne
Fabaceae	*Melilotus*	*albus*	white sweetclover, hubam sweetclover, white blossom sweetclover
Fabaceae	*Melilotus*	*indicus*	sourclover
Fabaceae	*Melilotus*	*officinalis*	yellow sweetclover, yellow blossom sweetclover
Fabaceae	*Phaseolus*	*coccineus*	scarlet runner bean
Fabaceae	*Phaseolus*	*lunatus*	lima bean
Fabaceae	*Phaseolus*	*vulgaris*	field bean, garden bean
Fabaceae	*Pisum*	*sativum*	pea, garden pea, field pea

Family	Genus	Specific epithet	common names
Fabaceae	*Securigera*	*varia*	crownvetch
Fabaceae	*Sesbania*	*exaltata*	tall indigo, peatree, Colorado river-hemp, hemp sesbania
Fabaceae	*Trifolium*	*campestre*	large hop clover, low hop clover
Fabaceae	*Trifolium*	*dubium*	small hop clover, suckling clover, Irish shamrock
Fabaceae	*Trifolium*	*fragiferum*	strawberry clover
Fabaceae	*Trifolium*	*hirtum*	rose clover
Fabaceae	*Trifolium*	*hybridum*	alsike clover
Fabaceae	*Trifolium*	*incarnatum*	crimson clover
Fabaceae	*Trifolium*	*pratense*	red clover
Fabaceae	*Trifolium*	*repens*	ladino clover, white clover
Fabaceae	*Trifolium*	*subterraneum*	subterranean clover, subclover
Fabaceae	*Trifolium*	*vesiculosum*	arrowleaf clover
Fabaceae	*Vicia*	*benghalensis*	purple vetch
Fabaceae	*Vicia*	*cracca*	bird vetch, boreal vetch, tufted vetch
Fabaceae	*Vicia*	*faba*	broadbean, fava-bean, horsebean
Fabaceae	*Vicia*	*sativa*	common vetch
Fabaceae	*Vicia*	*villosa*	hairy vetch
Fabaceae	*Vigna*	*radiata*	mung bean
Fabaceae	*Vigna*	*unguiculata*	black-eyed pea, cowpea, southern-pea
Geraniaceae	*Erodium*	*cicutarium*	alfilaria, redstem filaree
Geraniaceae	*Geranium*	*dissectum*	cutleaf geranium
Hypericaceae	*Hypericum*	*perforatum*	St. John's-wort; klamathweed
Juncaceae	*Juncus*	*tenuis*	path rush
Lamiaceae	*Dracocephalum*	*parviflorum*	American dragonhead
Lamiaceae	*Lamium*	*amplexicaule*	henbit
Lamiaceae	*Mentha*	*×piperita*	peppermint
Lamiaceae	*Nepeta*	*cataria*	catnip
Lamiaceae	*Ocimum*	*basilicum*	sweet basil
Lamiaceae	*Prunella*	*vulgaris*	heal-all, self-heal
Lamiaceae	*Salvia*	*officinalis*	sage
Lamiaceae	*Teucrium*	*canadense*	American germander, wood-sage
Linaceae	*Linum*	*usitatissimum*	flax
Malvaceae	*Abelmoschus*	*esculentus*	okra
Malvaceae	*Abutilon*	*theophrasti*	butterprint, velvetleaf
Malvaceae	*Gossypium*	*hirsutum*	upland cotton
Malvaceae	*Malva*	*parviflora*	little mallow
Malvaceae	*Malvella*	*leprosa*	alkali mallow, alkali sida
Malvaceae	*Sida*	*spinosa*	prickly mallow, prickly sida
Oxalidaceae	*Oxalis*	*stricta*	yellow woodsorrel
Papaveraceae	*Papaver*	*rhoeas*	corn poppy
Pedaliaceae	*Sesamum*	*indicum*	sesame
Pinaceae	*Abies*	*concolor*	white fir
Pinaceae	*Pinus*	*ponderosa*	ponderosa pine, western yellow pine
Plantaginaceae	*Plantago*	*aristata*	bracted plantain

Family	Genus	Specific epithet	common names
Plantaginaceae	*Plantago*	*lanceolata*	buckhorn, buckhorn plantain
Plantaginaceae	*Plantago*	*major*	broadleaf plantain, common plantain
Plantaginaceae	*Plantago*	*rugelii*	blackseed plantain, Rugel's plantain
Plantaginaceae	*Plantago*	*virginica*	paleseed plantain, Virginia plantain
Plantaginaceae	*Veronica*	*officinalis*	common speedwell
Poaceae	*Achnatherum*	*hymenoides*	Indian ricegrass
Poaceae	*Aegilops*	*cylindrica*	jointed goatgrass
Poaceae	*Agropyron*	*desertorum*	standard crested wheatgrass
Poaceae	*Agrostis*	*capillaris*	colonial bentgrass
Poaceae	*Agrostis*	*gigantea*	redtop
Poaceae	*Alopecurus*	*geniculatus*	water foxtail
Poaceae	*Alopecurus*	*pratensis*	meadow foxtail
Poaceae	*Andropogon*	*gerardii*	big bluestem
Poaceae	*Anthoxanthum*	*odoratum*	sweet vernalgrass
Poaceae	*Apera*	*spica-venti*	windgrass
Poaceae	*Arrhenatherum*	*elatius*	tall oatgrass
Poaceae	*Avena*	*fatua*	wild oat
Poaceae	*Avena*	*sativa*	oat
Poaceae	*Axonopus*	*fissifolius*	carpetgrass
Poaceae	*Bothriochloa*	*ischaemum*	yellow bluestem
Poaceae	*Bouteloua*	*curtipendula*	side-oats grama
Poaceae	*Bouteloua*	*dactyloides*	buffalograss
Poaceae	*Bouteloua*	*gracilis*	blue grama
Poaceae	*Bromus*	*catharticus* var. *cartharticus*	prairie brome, rescuegrass
Poaceae	*Bromus*	*commutatus*	hairy brome, hairy chess
Poaceae	*Bromus*	*diandrus* var. *rigidus*	ripgut brome, giant brome
Poaceae	*Bromus*	*hordeaceus*	blando brome, soft chess
Poaceae	*Bromus*	*inermis* subsp. *inermis*	smooth brome, smooth bromegrass
Poaceae	*Bromus*	*japonicus*	Japanese brome, Japanese chess
Poaceae	*Bromus*	*secalinus*	cheat, chess
Poaceae	*Bromus*	*tectorum*	downy brome
Poaceae	*Cenchrus*	*spinifex*	coast sandbur, field sandbur
Poaceae	*Chloris*	*gayana*	rhodesgrass
Poaceae	*Cynodon*	*dactylon* var. *dactylon*	bermudagrass
Poaceae	*Cynosurus*	*cristatus*	crested dogtail
Poaceae	*Dactylis*	*glomerata*	orchardgrass
Poaceae	*Digitaria*	*ischaemum*	smooth crabgrass
Poaceae	*Digitaria*	*sanguinalis*	hairy crabgrass, large crabgrass
Poaceae	*Echinochloa*	*crus-galli*	barnyardgrass
Poaceae	*Echinochloa*	*frumentacea*	Japanese millet
Poaceae	*Eleusine*	*indica*	goosegrass
Poaceae	*Elymus*	*canadensis*	Canada wildrye
Poaceae	*Elymus*	*lanceolatus*	streambank wheatgrass, thickspike wheatgrass, northern wheatgrass
Poaceae	*Elymus*	*repens*	quackgrass

Family	Genus	Specific epithet	common names
Poaceae	*Elymus*	*trachycaulus*	slender wheatgrass
Poaceae	*Elymus*	*virginicus*	Virginia wildrye
Poaceae	*Eragrostis*	*cilianensis*	strong-scented stinkgrass
Poaceae	*Eremochloa*	*ophiuroides*	centipedegrass
Poaceae	*Eriochloa*	*aristata*	bearded cupgrass
Poaceae	*Festuca*	*arundinacea*	tall fescue
Poaceae	*Festuca*	*rubra*	creeping red fescue, red fescue and/or chewings fescue
Poaceae	*Festuca*	*trachyphylla*	hard fescue
Poaceae	*Glyceria*	*grandis*	American mannagrass
Poaceae	*Holcus*	*lanatus*	velvetgrass
Poaceae	*Hordeum*	*jubatum*	foxtail barley, squirreltail barley
Poaceae	*Hordeum*	*vulgare*	barley
Poaceae	*Leptochloa*	*dubia*	green sprangletop
Poaceae	*Lolium*	*multiflorum*	annual ryegrass, Italian ryegrass
Poaceae	*Lolium*	*perenne*	perennial ryegrass
Poaceae	*Lolium*	*persicum*	Persian darnel, Persian ryegrass
Poaceae	*Lolium*	*temulentum*	darnel, poison ryegrass
Poaceae	*Nassella*	*trichotoma*	serrated tussock
Poaceae	*Nassella*	*viridula*	green needlegrass
Poaceae	*Oryza*	*sativa*	rice
Poaceae	*Panicum*	*capillare*	witchgrass
Poaceae	*Panicum*	*miliaceum* subsp. *miliaceum*	broomcorn millet, proso millet
Poaceae	*Panicum*	*virgatum*	switchgrass
Poaceae	*Pascopyrum*	*smithii*	western wheatgrass
Poaceae	*Paspalum*	*dilatatum*	dallisgrass
Poaceae	*Paspalum*	*notatum*	bahiagrass
Poaceae	*Pennisetum*	*ciliare*	hairy buffelgrass
Poaceae	*Pennisetum*	*glaucum*	pearl millet
Poaceae	*Phalaris*	*arundinacea*	reed canarygrass
Poaceae	*Phalaris*	*canariensis*	canarygrass
Poaceae	*Phleum*	*pratense*	timothy
Poaceae	*Poa*	*annua*	annual bluegrass
Poaceae	*Poa*	*bulbosa*	bulbous bluegrass
Poaceae	*Poa*	*compressa*	Canada bluegrass
Poaceae	*Poa*	*pratensis*	Kentucky bluegrass
Poaceae	*Poa*	*trivialis*	rough bluegrass
Poaceae	*Psathyrostachys*	*juncea*	Russian wildrye
Poaceae	*Pseudoroegneria*	*spicata*	beardless wheatgrass, bluebunch wheatgrass
Poaceae	*Schizachyrium*	*scoparium*	little bluestem
Poaceae	*Secale*	*cereale*	rye
Poaceae	*Setaria*	*faberi*	giant foxtail
Poaceae	*Setaria*	*italica* subsp. *italica*	foxtail millet, Italian millet
Poaceae	*Setaria*	*parviflora*	knotroot bristlegrass

Family	Genus	Specific epithet	common names
Poaceae	*Setaria*	*pumila* subsp. *pumila*	yellow bristlegrass, yellow foxtail
Poaceae	*Sorghastrum*	*nutans*	yellow indiangrass
Poaceae	*Sorghum*	×*almum*	almum sorghum; Columbus grass
Poaceae	*Sorghum*	*bicolor* nothosubsp. *drummondii*	sudangrass, sorghum-sudangrass
Poaceae	*Sorghum*	*bicolor* subsp. *bicolor*	broom corn, milo, shattercane, sorghum
Poaceae	*Sorghum*	*halepense*	johnsongrass
Poaceae	*Sporobolus*	*airoides*	alkali sacaton
Poaceae	*Taeniatherum*	*caput-medusae*	medusahead, medusahead rye
Poaceae	*Thinopyrum*	*ponticum*	tall wheatgrass
Poaceae	*Triticum*	*aestivum* subsp. *aestivum*	common wheat
Poaceae	*Triticum*	*aestivum* subsp. *spelta*	spelt
Poaceae	*Triticum*	*turgidum* subsp. *durum*	durum wheat
Poaceae	×*Tritosecale*	*spp.*	triticale
Poaceae	*Urochloa*	*ramosa*	browntop millet
Poaceae	*Vulpia*	*myuros*	rattail fescue
Poaceae	*Vulpia*	*octoflora*	six-weeks fescue
Poaceae	*Zea*	*mays*	corn
Polygonaceae	*Fagopyrum*	*esculentum*	buckwheat, common buckwheat
Polygonaceae	*Fallopia*	*convolvulus*	black bindweed, wild buckwheat
Polygonaceae	*Persicaria*	*lapathifolia*	pale smartweed
Polygonaceae	*Persicaria*	*maculosa*	ladysthumb
Polygonaceae	*Polygonum*	*aviculare*	prostrate knotweed
Polygonaceae	*Rheum*	*x rhabarbarum*	rhubarb
Polygonaceae	*Rumex*	*acetosa*	sorrel, garden sorrel
Polygonaceae	*Rumex*	*acetosella*	red sorrel, sheep sorrel
Polygonaceae	*Rumex*	*crispus*	curly dock, sour dock
Portulacaceae	*Portulaca*	*oleracea*	purslane
Primulaceae	*Anagallis*	*arvensis*	scarlet pimpernel
Ranunculaceae	*Ranunculus*	*abortivus*	small-flower buttercup, small-flower crowfoot
Ranunculaceae	*Ranunculus*	*acris*	tall buttercup
Ranunculaceae	*Ranunculus*	*repens*	creeping buttercup
Rosaceae	*Rosa*	*multiflora*	multiflora rose
Rubiaceae	*Galium*	*aparine*	cleavers, galium
Rubiaceae	*Richardia*	*scabra*	Florida pusley, Mexican-clover
Rubiaceae	*Sherardia*	*arvensis*	field madder
Sapindaceae	*Acer*	*rubrum*	red maple
Sapindaceae	*Cardiospermum*	*halicacabum*	ballonvine, heartseed
Scrophulariaceae	*Verbascum*	*thapsus*	common mullein
Solanaceae	*Capsicum*	*spp.*	pepper
Solanaceae	*Datura*	*stramonium*	jimsonweed
Solanaceae	*Nicotiana*	*tabacum*	tobacco
Solanaceae	*Physalis*	*alkekengi*	chinese lanternplant
Solanaceae	*Solanum*	*carolinense*	Carolina horsenettle, bullnettle

Family	Genus	Specific epithet	common names
Solanaceae	*Solanum*	*elaeagnifolium*	white horsenettle, purple nightshade, silverleaf nightshade
Solanaceae	*Solanum*	*lycopersicum* var. *lycopersicum*	tomato
Solanaceae	*Solanum*	*melongena*	eggplant
Solanaceae	*Solanum*	*nigrum*	black nightshade
Solanaceae	*Solanum*	*ptychanthum*	eastern black nightshade
Solanaceae	*Solanum*	*rostratum*	buffalobur
Verbenaceae	*Verbena*	*stricta*	hoary vervain, woolly vervain
Zygophyllaceae	*Tribulus*	*terrestris*	puncturevine